WE AND OUR AGRICULTURE

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Foreword

Agriculture is the mainstay of our country Practically every economic activity associated with the socio-ecological development in the country owes its genesis to agriculture in one way or the other Such a statement may sound strange to many who perceive agriculture merely as an art and science of growing useful plants. In fact, today the definition of agriculture has broadened in its scope Today's agriculture encompasses within its fold the most diverse avocations like crop husbandry, sericulture, apiculture, pisciculture and pomology and a modern agriculturist represents a reasonably ideal blend of a cultivator, soil scientist, pathologist, economist, etc.

Besides, agriculture is organically linked with the very existence of our life through proper ecological balance. Agriculture is essentially based on the exploitation of natural resources and hence, its ecological sustainability has got to be assured at any cost. Every agricultural activity has a long chain of ecological reactions improving or degrading the ecological balance — so vital for our existence. This simply implies that every one must have clear and comprehensive perception of agriculture, its scope, its linkages with our life and the ways to improve agriculture so as to use it as a vehicle for betterment of the quality of our own life. This is possible if we consider agriculture in its totality — from the evolutionary, social, economic, scientific, technological and educational points of view.

The present booklet attempts at explaining the fascinating vast world of agriculture to our school children in a concise, yet pleasant-to-read form. The book reveals the diversity of agricultural crops, animals, climate, soils and other elements of agriculture and explains how it gives rise to the most diverse economic activities of the people. The role of education in improving the output from agriculture is elucidated through examples of rural-based institutions of farm research, training and education set-up in the country under different government schemes.

The inspiration to develop this informative booklet on agriculture for school children came from the deliberations of the Consultative Committee of Parliament for the Ministry of Agriculture and on the initiative taken by the Ministry of Human Resource Development (Department of Education).

I hope that the booklet will be of interest not only to school children, but also to others, who are keen to know about agriculture in our country.

DR K. GOPALAN
Director
National Council of Educational
Research and Training

Preface

Although agriculture is the mainstay of majority of our people and it is equally important for millions of persons engaged in various agriculture-related activities through such diverse channels like processing, storage, marketing, transportation, banking, etc. yet most of us have just a vague concept about agriculture, not at all reflective of the latter's immense scope, potentialities and contribution towards very existence of our life on the earth. This is sadly true with most of our school children as well, who, despite their fairly adequate exposure to various facets of agriculture through school curriculum, know little about agriculture in our country and its linkages with every walk of our day-to-day life

The present booklet was developed by the NCERT at the initiative of the Ministry of Agriculture and Ministry of Human Resource Development (Department of Education) as our modest endeavour to provide school children with a source of supplementary information about agriculture. Subject specialists from agricultural universities, ICAR institutions, voluntary and private organisations, research and extension workers as well as teachers with rural background contributed towards writing of this booklet in a workshop conducted by the NCERT at Mitraniketan (Kerala) in January 1990 Their names are mentioned elsewhere in the booklet and their valuable contribution gratefully acknowledged. It was practically impossible to develop such a comprehensive book within a stipulated duration of the workshop but for whole-hearted cooperation from the friendly people of Mitraniketan under the guidance of its dynamic Director Shri K. Vishwanathan. We are highly grateful to them for their assistance and cooperation.

The booklet is a concise yet comprehensive account of agriculture in our country that familiarizes the readers with various components of agriculture and allied activities, effect of agriculture on ecological balance, improvement of agriculture through education and training, economic aspects of agriculture and pursuit of agriculture for the betterment of our life. All these important et largely diverse facets of agriculture are explained in simple and pleasant-to-read langua:e with inclusion of a good number of interesting illustrations.

Our sincere thank are due to Dr A. K Dhote, Reader in Agriculture and Project Coordinator for the cor :eption, design and development of this booklet which is expected to present agriculture n its multi-dimensional form before the young curious school children of our count

Comments on th booklet and suggestions for its improvement are welcome from the readers

ARUN K. MISHRA
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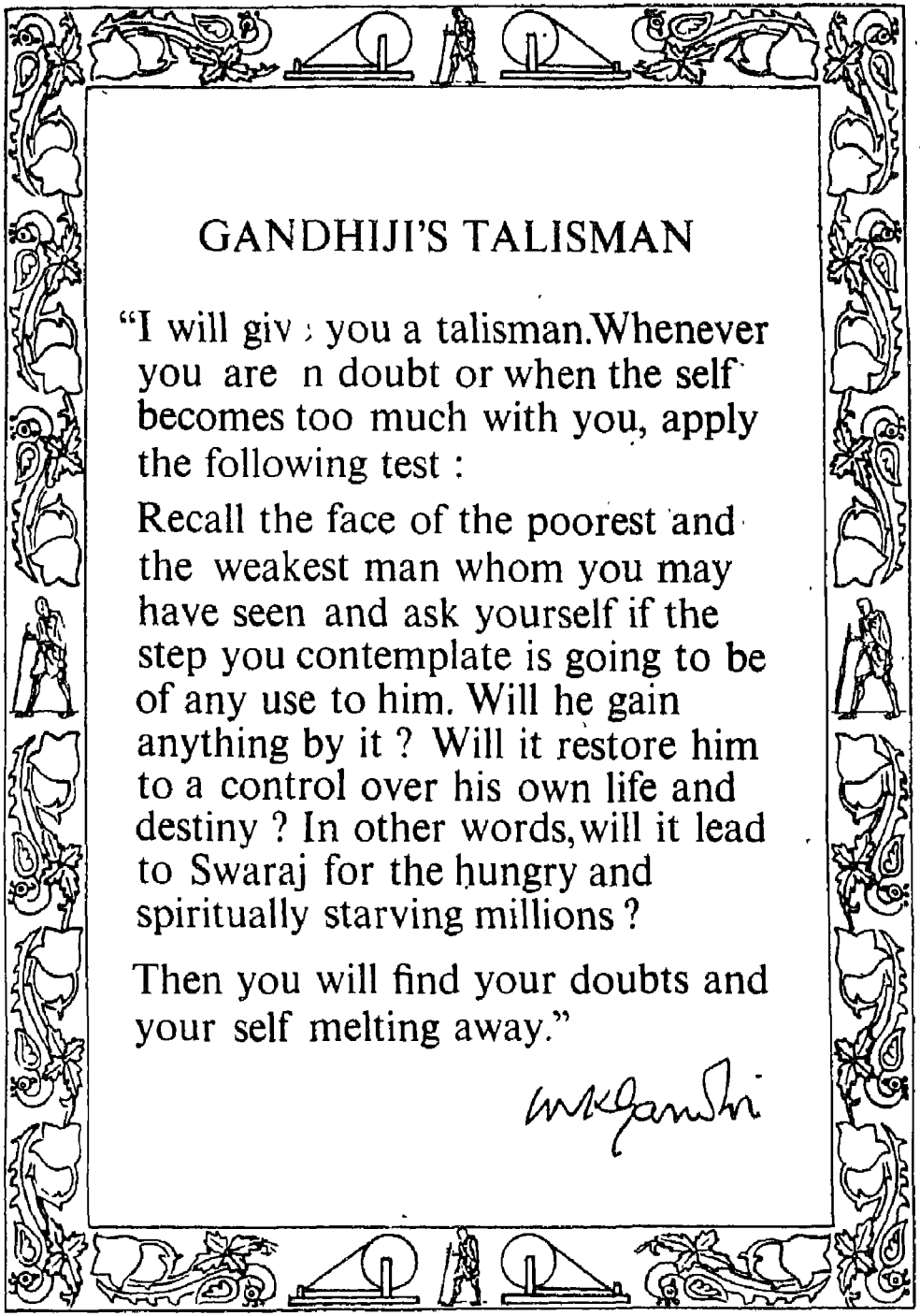

GANDHIJI'S TALISMAN

"I will giv : you a talisman. Whenever you are n doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

M K Gandhi

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CHAPTER 1

Agriculture in India – An Overview

I. CONCEPT

Agriculture is the backbone of Indian economy. About two-third of our population is dependent on agriculture which contributes over 30 per cent of Gross National Product. With about 75 per cent of Indian population living in rural areas, Indian agricultural scene is largely confined to villages.

Traditionally agriculture has been the means of subsistance to most of our villagers. However, with the recent scientific and technological achievements, the dependence on agriculture as a means of subsistance has largely changed. Agriculture is now a profit earning enterprise provided it is supported by scientific methods and judicious use of inputs.

Indian agriculture of yesteryears depended more on nature, had low inputs with the result that the income from agricultural produce was low. Recent rapid scientific achievements in agriculture have emphasised that inputs are the key factors for higher returns. This is largely true for all the agricultural operations.

In its broad sense, agriculture includes not only the cultivation of various crops but also animal husbandry, poultry, fishery, sericulture, piggery, apiculture, mushroom cultivation and all such related areas. A variety of crops are available in our country which include *field crops* like paddy, wheat, barley, maize, millets, pulses, oil seeds, *vegetables* like potato, tomato, crucifers, cucurbits, *fruit crops* like mango, apple, citrus, *plantation crops* like tea, coffee, coconut, cashew, *industrial crops* like cotton, jute, tobacco, *spices* like black pepper, cardamom, ginger, clove, *medicinal and aromatic plants* like eucalyptus, bellandona, etc.

Scientific cultivation of crops precisely demands a cultivator to judiciously choose a specific crop and its varieties depending upon the availability of resources at his command, and the climatic and soil conditions. From the choice of variety to post harvest processing/marketing, a number of operations are required to be precisely followed. These include field prepartion, presowing appli-

cation of fertilizers, sowing the seed at an appropriate depth and spacing, timely intercultural operations, irrigation schedule, top dressing with fertilizers, various plant protection measures against insects, diseases and weeds and timely harvesting. Farmer should also know the initial fertility level of his soil before deciding the amount of fertilzers to be applied.

Similarly for scientific animal husbandry and poultry farming a number of operations must be precisely followed. These include rearing of animals, balanced diet, health care and hygiene, shelter care and sanitation, breeding cycle, health care of pregnant animals, nursing of young ones, incubation of eggs, etc. Careful handling and marketing of the animal products such as milk, meat, eggs, hair etc. result in increased profits.

India has a rich aqua-wealth in the form of long coastal line, numerous perennial rivers, rivulets, ponds, reservoirs, bunded fields etc. These resources mostly underutilised can be profitably used for fish culture. Fishery offers a number of economically viable avocations which can be well integrated with mixed farming. Fish rearing in combination with paddy cultivation is a new trend in Indian agriculture. Successful fish farming depends on several factors like availability of pure and suitable fish-seed, proper pond management, feeding, protection against diseases, pests and predators, use of proper fishing gears, transportation, storage and marketing. Each of these activities offer a lot of scope for employment and earning money.

Sericulture is one of the most labour intensive branches of agriculture. Different species of silk worms feed on different host plants like mulberry, oak, castor etc. Most of the silk produced in India is obtained from mulberry silkworm. Incidentally mulberry cultivation can be successfully extended even to rainfed areas of the country, and silk production in the country can be greatly increased. Any further increase in silk production depends upon the availability of certain basic facilities like grainage for disease free pure silkworm seeds, suitable varieties of host plants, improved agronomic practices for cultivation of host plants, protection measures against diseases, pests and predators of worms and marketing facilities for cocoons at appropriate time and infrastructural facilities for further processing of silk and its by products.

Apiculture or honey-bee keeping is yet another important agricultural vocation which gives high profits. Besides economic returns in the form of the honey and wax, the farmer also gets better yield of neighbouring crop plants by way of increased cross pollination activity by honey-bees. Successful apiculture calls for procurement of appropriate species of honey-bee and its placement in a suitably designed rearing box, which is placed in

an open area having plenty of nectar bearing plants. Simple and inexpensive tools and implements for rearing of bees and extraction of honey are needed.

Mushroom culture is another agricultural vocation which is rapidly growing because of the high nutritive value of the produce. Mushroom is an indoor crop, does not need sunlight, feeds an organic matter and requires very little land. Important steps for a successful mushroom culture involve: appropriate choice of the spices of mushroom, availability of the required growth medium or substrata, housing facilities with temperature and light controls and timely harvesting and marketing.

II. SCOPE

Our life is highly dependent on plants. We get our daily chapati, bread, rice and pulses from plants. The milk, butter, ghee which we eat are derived from milch animals like cows and buffaloes that, in turn, are dependent on plants for their food. A large number of other food crops, vegetables, fruits, ornamentals, oil seeds, fibre crops (e.g. cotton, jute, sunhemp etc.), industrial crops (tea, coffee, sugarcane, tobacco etc.), spices (cardamom, ginger, pepper etc.), are part and parcel of our daily life. Besides, a number of medicines, timber for our homes, and paper for our books are plant products. In fact it is difficult to imagine the existence of human society without active support of plants. It is quite natural that a vast variety of plant spices are cultivated for their end use.

Food is our basic necessity, a large part of which comes from plant sources. With scientific achievements, industrialisation and modern aids in living, the importance of agriculture as the basic source of food cannot be undetermined. There is a greater demand for food for fast growing world population while our resources of food production are limited. This is specially applicable to our country. Taking 1971 as base year, the total food production in India increased to the tune of about 12 per cent in the next decade ending 1981 while the population showed a 25 per cent increase during the same period. The population grows in geometric proportion while the resources of food production are near fully exploited. Keeping this in mind the future years seem to be quite difficult. It is, therefore, important that the increasing gap between food production and population growth is narrowed down. But our resources of production are already showing the signs of near exhaustion. The only possible answer to this problem appears maximising food production while keeping the population growth low. There cannot be a subsitute for greater food production.

III. HOW AGRICULTURE CHANGES AS PER SOIL CLIMATIC CONDITIONS

Great diversity of meteorological conditions in India have resulted in several kinds of weather which, coupled with varied soils, greatly influence the crops and cropping pattern. Thus we have desert and semi-desert areas in Rajasthan and swamp/marshy lands in Kutch region of Gujarat. The soil ranges from light alluvial in Indo-Gangetic plains to heavy black cotton in Central India. The climate ranges from humid in Assam to arid in Rajasthan. Winter experiences severe snow fall in northern hills and Kashmir valley while the minimum temperature in peninsular and Central India is comfortable. Normal rainfall varies from more than 11500 mm in Assam hills to less than 75 mm in Rajasthan. During monsoon period some areas get inundated while some others go dry or receive scanty rains. Conditions in south are quite different than in north. Similarly the Himalaya regions are quite different from the plains and coastal conditions are again different than those in interior.

Crop husbandry, which largely depends on nature, is highly influenced by weather conditions specially rainfall and temperature. With highly diverse climatic and soil conditions in India, it is but natural that crops and cropping patterns also change accordingly. Thus, there are regional adaptations of crops which are highly influenced by climate. Jute, for example, is cultivated in humid eastern delta areas, coconut along the warm humid coastal line, tea under low temperature and humid climate on lands with light percolative slopes, cotton in dry, warm belt of central India with heavy black-cotton soils, apple in hilly regions with very low temperature and so on.

On the other hand, there are crops that are relatively less influenced by changing climatic and soil conditions. It is possible that the quality of produce or yield are slightly adversely affected because of change of adaptive environment, yet one may raise a fairly successful crop. For example, wheat is grown almost all over the country ranging from high hills of north to plains, to coastal belt of India. Of course, there are significant yield variations when the crop is raised in northern plains with low winter temperatures compared to the one raised in relatively warmer areas of peninsular or coastal India. Similarly, rice is also widely adapted and is cultivated in practically whole of India including hills. A number of vegetables e.g. tomato, chillies, cucurbits and some pulses like pigeon pea and cow pea and blackgram are other examples of plants having high adaptability to environmental conditions.

Animal husbandry also shows its wide range of variability depending upon cli-

matic and soil factors. For milk purpose we rear cows and buffaloes in warm or moderately warm plains, but find sheep, goats and camels in desert hot areas, yaks and mithuns in cold alpine areas. Chickens are reared for meat and eggs in all parts of the country, but we find mostly ducks in damp, humid areas with plenty of water-bodies. Wool is obtained from sheep and goats in the desert areas, but rabbit rearing for fine Angora wool is confined to the cool belt of Himalayan ranges. We do not find much of cattle in desert arid areas with scanty, thorny bushy vegetation, but there are lot of sheep, goats and camels who relish such thorny plants.

Besides the crops, the cropping patterns also vary from condition to condition and region to region.For example, in areas with ample and assured irrigation, farmers reap two or sometimes three crops in a year. On the contrary, one crop is possible in areas dependent on rain. When assured inputs are available, several combinations of various crops suited to different growing seasons are possible. Farmers may have their choice of crops and crops combinations. One kharif crop followed by a rabi crop, which, in turn may be followed by short summer or Zaid crop, is an example of intensive cultivation. The crops may rotate as follows:

Maize-Wheat-Summer Moong;

–Paddy-Brassica-Summer Moong etc.

Many more such combinations are possible. This kind of cultivation of crop in quick succession around the year is known as multiple cropping. This package, though labour intensive, allows greater economic returns per unit area.

IV. IMPORTANT AGRICULTURAL CROPS OF INDIA

1. Field Crops

(i) Wheat : In terms of production, wheat *(Triticum* spp.*)* occupies the prime position among the food crops of the world. In India it is the second important food crops being next to rice in area and production. It is consumed mostly in the form of unleavened pan baked bread, called chapati. Wheat straw is used for feeding cattle. The Indo-Gangetic plains form the most important wheat areas. The cool winters and hot summers are very conducive to a good crop of wheat. Some important cultivated varieties are Sonalika, Kalyansona, Arjun, HD 2329, WL 711.

(ii) Rice : It *(Oryza Sativa)* is the most important food grain in India in terms of areas under the crop and total annual production. Kharif and rabi are the two main seasons for the crop. However, three crops are taken annually in the southern states of Tamil Nadu and Kerala. With adoption of high-yielding varieties of wheat and rice in recent years, India has gradually transformed into self sufficient

country. Important varieties of paddy are Jaya, Ratna, Saket 4, Mahsuri and IR 36.

(iii) Other Cereals : Maize, barley and oats are the other major cereal crops grown in India apart from rice and wheat. Maize has maximum productivity among cereals. Barley is an important rabi cereal of India ranking next to wheat both in acrage and in the production of grains. The oats crop however occupies small area. All these crops are utilised either as food, fodder or as industrial raw material.

(iv) Millets : Millets form staple food in certain parts of India. Sorghum, popularly known as jowar or great millet is the most important food and fodder crop of dry land agriculture. It is mainly concentrated in the peninsular and central India. Other millets include bajra or pearl millet, kodo, fox tail, little proso, and barnyard millet. Millets with their high protein and mineral content are superior to rice and equal to wheat in quality.

(v) Pulses : Pulses form an important part of Indian dietary. They are an important source of protein, are essential adjuncts to a predominantly cereal-based diet and enhance the biological value of protein consumed. Being leguminous crops possessing root nodules, they fix and utilise atmospheric nitrogen. They add upto 30 kg. N/ha to the soil and improve its fertility. Chickpea (Gram) and pigeon pea (arhar) are the two most important pulse crops of India covering more than 45 per cent of the total area under pulses and contributing about 60 per cent of the total pulse production. Black gram, green gram, cowpea, horse gram, lentil, moth bean and peas are other important pulse grown in India. They are used as food, fodder, green manure crop, cover crop, vegetable crop, firewood, soil renovator or as thatching material.

FIELD CROPS

Cereals	:	Rice, Wheat, Barley, Oats, Maize.
Millets	:	Sorghum, Bajra, Finger millet, Kodo millet, Barnyard millet.
Pulses	:	Black gram, Green gram, Gram (bengal gram), Cowpea, Pea, Lentil, Pigeon pea, Kidney bean, Lathyrus.
Oil Seeds	:	Black mustard, Brown sarson, Castor, Groundnut, Rapeseed or Yellow sarson, Indian mustard, Linseed, Niger, Safflower, Sunflower, Soyabean, Sesame, Eruca (Rocket salad).
Fibre Crops	:	Cotton, Jute, Sun hemp, Sisal hemp, Brown hemp, Rozelle.
Sugar and Starch Crops	:	Sugarcane, Tapioca, Sugarbeet.
Fodder Crops	:	Bermuda grass, Blue panic, Elephant grass (Napier grass), Bur clover, Egyptian clover, Indian clover, Persi clover, Guinea grass, Johnson grass, Lucern, Kudzu grass, Sudan grass, Sunflower, Rhodes grass, Star grass, Teosinte, Velvet bean, Pennisitum spp, Setaria spp.

(vi) Starch Crops : Several root and tuber crops are used as food, live stock, feed, medicine and for industrial purposes. Potato is the most important starch crop which is used as vegetable. Tapioca (cassava), sweet potato, yams, cocoyam, chinese potato, are other major tuber crops grown in India. The tuber crops are rich source of carbohydrates and form a staple diet in several north-eastern states and Kerala.

2. Commercial Crops

(i) Oil Seeds : In India wide range of oil yielding plants such as groundnut, rapeseed, mustard, sesamum, safflower, sunflower, linseed, soyabean, niger and castor are cultivated. India occupies a prominent position in the world for the production of each of the traditional oil seed crops except sunflower and soyabean which are newly introduced to the country. A number of tree species like coconut, mahua, karanj, sal, neem, kusum and the recently introduced oil palm also yield industrial as well as edible oils.

(ii) Sugar Crops : Sugarcane and sugarbeet are two main sugar crops. India is the largest cultivator of sugarcane and the biggest producer of cane sugar in the world. Unlike sugarcane which is a crop of the tropics, sugarbeet is essentially a crop of the temperate region.

(iii) Fibre Crops : In spite of having the largest acrage under cotton, India holds only fourth position among cotton growing countries, after China, the United States and the Soviet Union. Cotton forms the most important raw material for textile mills. Jute, another fibre crop, also has an important place in Indian economy. Indian jute goods account for nearly 50 per cent of world production and their share in global exports was steady at 28 per cent for a long time. Other important fibre yielding crops of India are mesta, ramie, sisal, sun hemp, flax and congo jute.

(iv) Tobacco : Though the tobacco plant is tropical in origin, its production at present is concentrated mostly outside the tropics except in India. India has a prominent position in the tobacco world, it ranks third after China and the United States in cultivated area, fourth after Brazil in production and eighth in export. Almost all types grown in the world, except the oriental variety, are cultivated in India.

3. Plantation Crops

(i) Tea : It is made from the tender leaves and unopened buds of the ever-green tea plant. India is the largest producer and exporter of tea. Few agro-industries in India contribute so much to the economy as the tea industry.

(ii) Coffee : Coffee is a major plantation crop, mainly cultivated in the hilly tracts of the three southern states viz. Karnataka, Kerala and Tamil Nadu. India occupies the fifth position among the major coffee producers.

(iii) Cocoa : It is one of the popular beverages after tea and coffee. Cocoa plantations are available in Kerala.

(iv) Rubber : Rubber tree is yet another important plantation tree of Kerala. It is a hardy, tall, quick growing tree from the trunk of which latex is obtained. The latex is a versatile industrial raw material which is used in the manufacture of about 50,000 different products.

(v) Coconut : Coconut is the most widely grown plantation crop of India which is grown all along the coastal line. It is mainly cultivated for the nuts from which 'Copra' and fibre are obtained. 'Copra' yields oil and oil cake and fibre is made into coir. The trunk of the mature coconut tree is used as timber and the plaited leaves are used for thatching homes, fencing etc. The unopened spathe is taped for toddy, which is used as a tonic, or converted to jaggery and sugar or fermented to a mild alcoholic drink and vinegar. Water from tender coconut is a refreshing and delicious drink. The coconut shell is largely used as a fuel and for the production of charcoal and making a variety of curios. The shell flour is used as a filler in plastics. Thus every part of the palm is useful in one way or another. India stands third in the world for coconut cultivation and production.

(vi) Arecanut : Arecanut more popularly known as betelnut is an extensively cultivated tropical palm the nuts of which form a popular masticatory in India, the middle east and the far east. It is a tall stemmed erect palm.

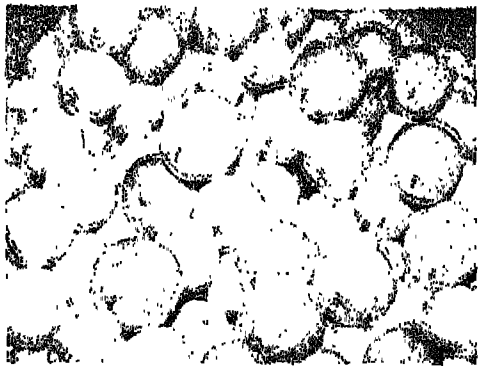
(vii) Cashew : Cashewnut has emerged as one of the three major foreign exchange earners for India. It has a high nutritive value and offers considerable employment potential as its processing is quite labour intensive. India is the world's leading producer and exporter of cashew kernels.

4. Horticultural Crops

(i) Fruit Crops : Fruits have considerable commercial importance. From time immemorial fruits have had nutritional, social and economic importance. Until recently India was the second largest producer of fruits next only to Brazil but has now slid to the third position after United States.

India occupies the place of pride in respect of the wide range of fruits grown, yield and quality of table grapes and the quantum of production of mango and

Plantation Crops	:	Coconut, Arecanut, Coffee, Tea, Rubber, Cocoa, Cinchona.
Spices and Condiments	:	Aromatic cardamom, large cardamom, Black pepper, Cardamom Chilli, Coriander, Cumin, Fennel, Fenugreek (Methi), Garlic, Ginger, Mustard, Black mustard, Dill seed, Long pepper, Mint, Nutmeg (Jaiphal), Turmeric, Betelvine.



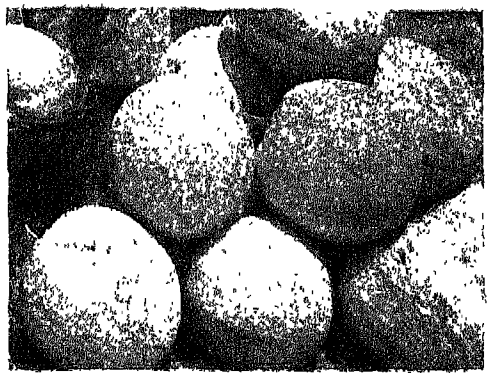
Diverse climatic conditions in the country enable the farmers to grow different fruit crops.

FRUIT CROPS

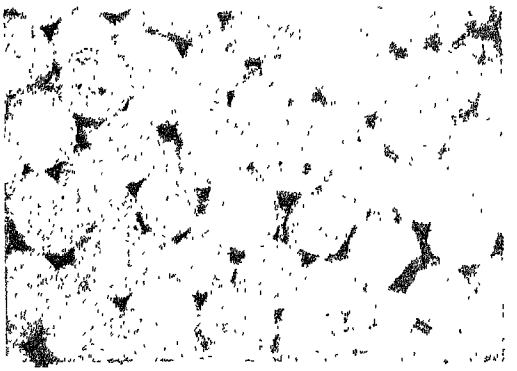
Mango, Banana, Apple, Apricot, Avocado, Litchi, Guava, Loquat, Mulberry, Papaya, Peach, Gooseberry, Raspberry, Pomegranate, Plum, Pear, Strawberry, Orange, Malta, Cherry, Cashew, Custard apple, Grape fruit, Fig, Grape vine, Lime, Jack fruit, Jujube, Persimon, Pine apple, Rough lemon, Sapota, Sweet lime, Pomelo, Bullock's heart, Phalsa, Kinnow

apple. India is the world's largest producer of mango as well. Besides, grapes and mango, a variety of fruits are grown in India which include banana, guava, loquat, litchi, plum, pear, apricot, peach etc.

(ii) Vegetables : Vegetables have exclusive importance in providing vitamins and minerals in the diet, besides supplying protein and energy. They play a significant role in overcoming nutritional disorders. India is the second largest vegetable producer in the world next to China. Among about fifty vegetables grown, the major ones are potato, tomato, brinjal, onion, chillies, okra and a number of cucurbits. Mushroom which is also considered a vegetable is a high protein and mineral container. The protein content in mushroom is twice as high as in the most vegetables except green peas, Brussels sprout and pulses.

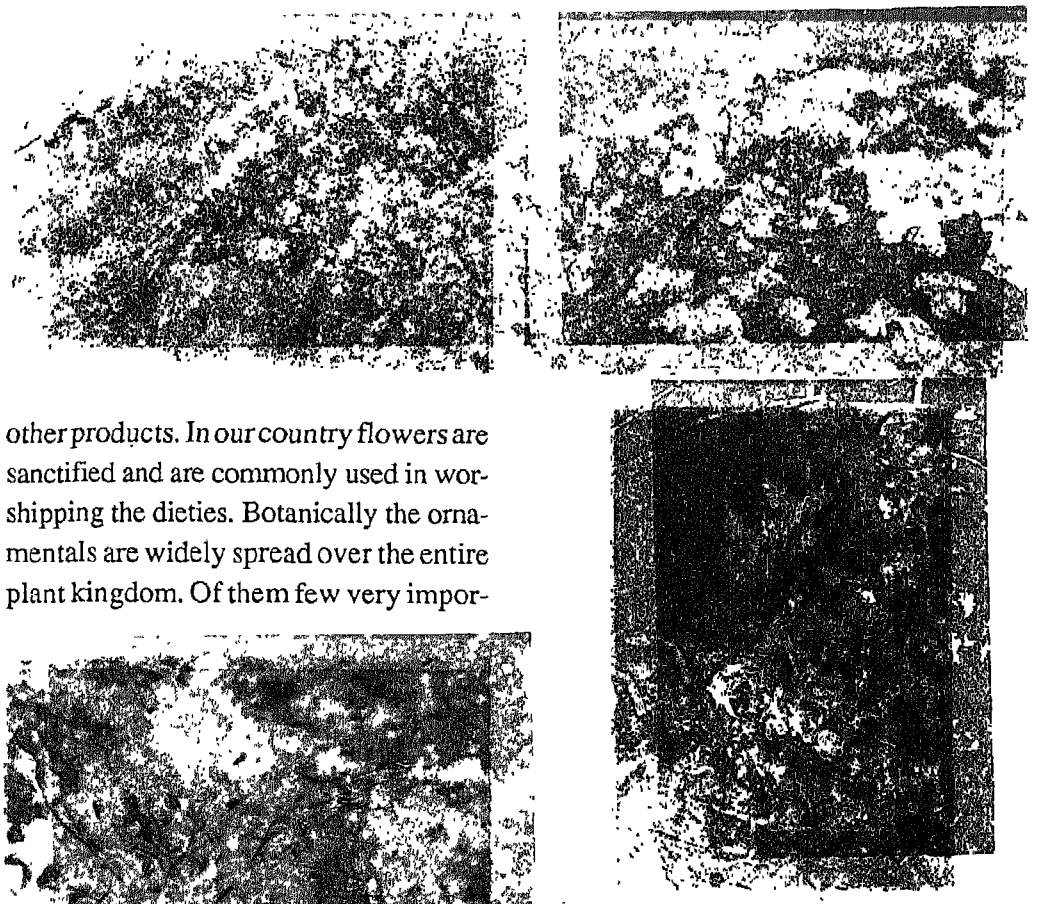


VEGETABLE CROPS		
Cole Crops	:	Cabbage, Cauliflower, knolknol.
Root Crops	:	Radish, Turnip, Carrot, beetroot.
Tuber Crops	:	Onion, Garlic.
Legumes	:	Cowpea, Broad bean, French bean, Cluster bean, Double bean, Indian bean, Velvet bean, Pea, Lima bean, Sword bean, Rajma.
Vegetables	:	Tomato, Brinjal, Ladies finger, Chilli.
Cucurbitaceous Crops	:	Ash gourd, Bottle gourd, Bitter gourd, Cucumber, Little gourd, Pumpkin, Musk melon, Red pumpkin, Smooth gourd, Ridge gourd, Snake gourd, Water melon, Pointed gourd, Indian squash melon, Long melon.
Tuber crops	:	Potato, Sweet potato.
Corms and Rhizomes	:	Colocassia, Dioscoria, Elephant foot, Greater yarn, Potato yarn.
Leafy Vegetables	:	Spinach, Ameranthus, Parslane, Chinapodium.



Nature is kind to our farmers producing fresh vegetables throughout the year.

(iii) Ornamentals : Flowers symbolise beauty, love and tranquility. Besides their aesthetic value they are important for their economic uses, such as for cut blooms and for extracting perfumes and



Cultivation of flower is a profitable business with ever increasing demand in domestic, industrial and export markets.

other products. In our country flowers are sanctified and are commonly used in worshipping the dieties. Botanically the ornamentals are widely spread over the entire plant kingdom. Of them few very important flowering plants useful for garden display, cut-flowers or the perfume industry are rose, jasmine, chrysanthemum, orchids, gladiolus, bougainvillea, tuberrose and marigold etc. Special mention may be made about orchids that make rich floral wealth of India.

5. Condiments and Spices

India is known as the 'land of spices' growing about 63 spices, of which black pepper, cardamom, ginger and turmeric are major ones. Varied are the uses to which spices have been put to from time immemorial. They are used as additives

and for the propitiation of the Gods. They also stimulate digestion on account of their carminative properties. Most of the spices find place in various medicines. India holds largest area under black pepper but has only the third place in production. The small cardamom is the second most important spice and India's position is second in the world next to Guatemala, in terms of production. India is the largest producer of ginger and turmeric in the world.

6. Medicinal and Aromatic Plants

They form a numerically large group of economically important plants which provide the basic raw materials for the indigenous pharmaceuticals, perfumery, flavour and cosmetic industries and help the country earn foreign exchange. Because of the vast areas and wide variations in soil, climate, India is one of the few countries where most of the medicinal and essential oil bearing plants can be cultivated. Among the various plants in great demand in the country and abroad are cultivated mints, aromatic grasses, rose, lavender, opium, poppy, tropane alkeloid-bearing plants, sapogenin-bearing yams, senna, psyllium husk and seeds and cinchona.

Drugs, dyes and narcotics	Poppy, henbane, hemp, Tobacco, Pyrethrum, Safflower, Indigo, Mehdi, Datura.

CHAPTER 2

Mixed Farming

Mixed farming is a combination of many enterprises related to agriculture which are of independent nature, resulting to a certain extent in the diversification of occupation. In India mixed farming generally means crop production along with livestock raising. Crop production can also be combined with poultry farming, pig farming, mushroom cultivation, sericulture etc. A farm is considered as a mixed type if at least ten per cent of its gross income is contributed by the secondary enterprises.

Advantages of Mixed Farming

1. Increase in the productivity of farm land and animals as the farm provides ample feeds and fodders to animals, who in term give manure (dung-urine) to the farm land.
2. Better use of farm animals for draught including transport purpose.
3. Rational and more effective use of farm labour.
4. Systematic recycling and proper use of farm by products and waste materials.
5. Better scope for intensive cultivation and hence, higher profit per unit input.
6. A sort of insurance in case of failure of the main crop.

Under Indian conditions one or more of the following enterprises can be combined with crop production.

I. ANIMAL HUSBANDRY

The feeding, breeding, management and disease control of farm animals is known as animal husbandry. This generally includes cattle farming, goat farming, sheep farming, hog farming and poultry farming.

1. Cattle Farming

The holdings of the majority of farmers in the country are small and fragmented. They do not keep the farmer busy all the year round. During the off season, he remains almost idle. Milk and milk prod-

ucts are the only source of animal protein in his diet. Moreover, the Indian farmer is still highly dependent on the bullock labour for tillage, irrigation and carting. Cattle husbandry as a part of mixed farming provides a steady income and keeps him busy all through the year.

Indian cattle belongs to two different species, *Bos indicus* i.e. the ox and *Bos bubalis* i.e. the buffalo. Both have distinct characteristics and do not interbreed. Buffaloes, commonly seen in India, are not meet with in Europe. The distinguishing features of a buffalo are its horns, which are markedly flattended, and triangular in cross section. There is also well marked ridge on the anterior half of the back of buffaloes in place of the hump. Cow and buffalo, both are excellent milch animals in India and at the same time they produce sturdy oxen and he-buffaloes which are used for various draft purposes in agriculture.

Cattle reari g in India is carried out under a variety of odd climatic and environmental conditions. The cultivator is generally poor and resourceless. Grazing during most of the year is poor except during the monsoon and available feeds are not enough to sustain the existing cattle production. Marketing facilities are extremely inadequate. In the absence of a marketing organisation and because of the small size of the herd and lack of resources with the cultivator, a middle man usually steps in to exploit the poverty of the cattle owner and takes away most of the profit of the industry. The cultivator is thus deprived of all incentive to pay proper attention to the development of his cattle.

In addition to the milk and milk products, the cattle droppings are the most important source of manure for the soil. Cowdung is universally recognized as superior to chemical fertilizers for the retention of humus in the soil and for maintaining its fertility. Carcases constitute an important source of national wealth. India is an important supplier of hides and skin to the international market. Horns, hoofs and bones are utilized in industries.

There are 26 breeds of cattle in India which can be broadly classified as draft, dairy and dual purpose breeds. The animal of dual-purpose breeds possess the dual qualities of milk and draft. Amritmahal, Nagore, Malvi and Hallikar are well known draft breeds. Deonor, Gir, Sindhi and Sahiwal are important breeds of dairy cattle. The cross breeds like Holstein-Friesian and Karna-Swiss are heavy milk producers and quite popular with dairy owners. These breeds have adapted to the warm and humid Indian conditions. Haryana, Kankrej, Tharparkar and Ongole are some of the important dual purpose breeds.

2. Goat Farming

One of the first animals to be domesti-

cated by man was goat. Goats provide milk, meat, hides, manure. They were commonly used for sacrificial purposes even in early biblical times. Domestic goats *(Capra hircus)* are descendants of pasang *(C. aegagrus),* represented in Europe by the Cretan and Cyclades races. East was probably their earliest home.

The goat is a versatile animal. It is known as 'poor man's cow' in India and as 'wet nurse' of infants in Europe. In addition to having a high milk potential, the dairy goats have other advantages including small space requirements, and less financial investment for animals and equipment. The goats start milking at about 18 months age, and they are prolific breeders since they usually give birth to twins.

Goat manure is good for soil. The solid excreta of the goat is several times richer in nitrogen content and phosphoric acid than those of cow or buffalo. Goat urine is equally rich in both nitrogen and potash, and is more valuable than that of any other animals.

3. Sheep Farming

Sheep are unique among domestic livestock, for they are reared for a variety of purposes and can be maintained under diverse environmental conditions. Sheep produce two different kinds of crops each year, wool and lambs, bringing in an income to the flock owner twice a year. Since the crops are entirely different, the price of one does not have a bearing on the other.

Sheep eat plants of much greater diversity than any other kind of livestock. This makes them excellent weed destroyers, a class of livestock that can turn waste into profit and at the same time, improve the appearence of many a farm. Since sheep eat roughage which is usually cheaper than the grain, they are especially well adapted to many areas which are unable to produce grain, profitably. Sheep do not require expensive building and equipment too.

Sheep are reared for wool, meat, milk and skin, but seldom for all at the same time. The wool produced by Indian sheep is always white, it is hairy and coarse. It may include a considerable quantity of different colour shades or combinations. The Indian wool is good for the carpet industry and more than 50 per cent is exported annually. Sheep meat is an important nutritious item in the diet of the non-vegetarian people.

Sheep manure is a valuable farm input in many intensive farming areas of the country. Since sheep prefer to graze on hill-tops and high lands, the droppings are left where they are usually most needed.

4. Hog Farming

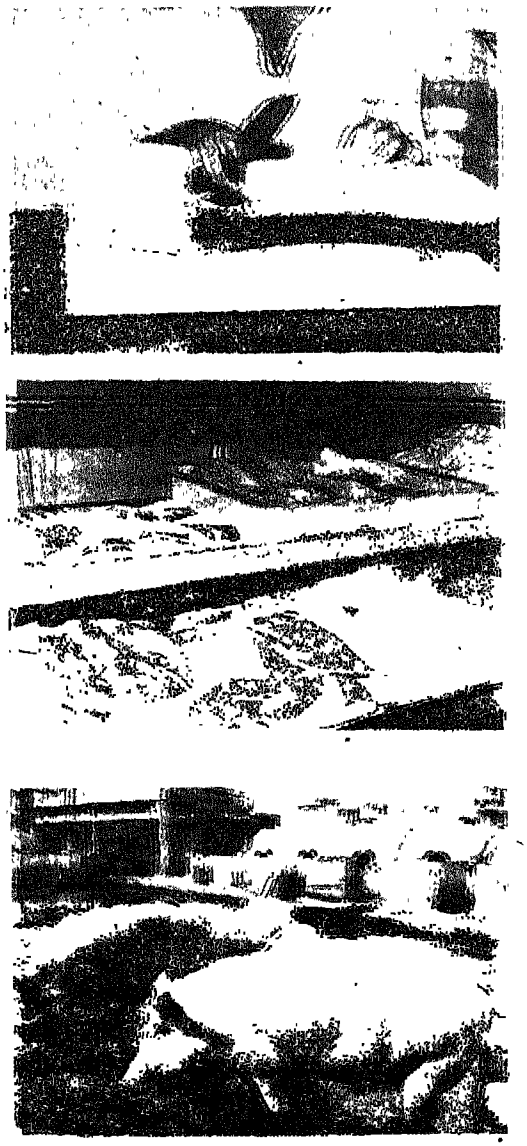
In India, hog raising and pork industry are in a primitive state. Pig rearing is almost entirely in the hands of poor people with

little resources who continue to follow ... and primitive methods. The common village hog in India is a slow grower animal and the pork is of very low quality. It is small sized and produces small litters. Under the prevailing conditions of management country hogs are mostly neglected.

Pig farming is adapted to both diversified and intensive agriculture. Pigs convert inedible feeds, forages, certain grain by products obtained from mills, meat by products, damaged feeds and garbage into valuable nutritious meat. Most of these feeds are either not edible or not very palatable to human beings. Pigs excel other animals in the efficiency with which they convert feed into meat. A kilogram of pork can be produced on as little as 2.5 to 3.5 kilograms of feed.

The faeces of pigs are useful in maintaining soil fertility as about 80 per cent of the fertilizing value of the feed is excreted in the faeces and urine. Rice-pig, Fish-pig and Poultry-pig are some of the important combinations of the integrated rice-farming system which have promise for many small and medium farmers.

The pig-farming neglected, so far has received greater attention under the National Five Year Plans. However, the future of the pig farming in this country will be determined to large extent by the demand of the people for pork and lard and their willingness to pay a reasonable price for these products.



Piggery succeeds under any farm conditions bringing additional income through manufacture/sale of pork product like ham, sausages, salami, kababs etc.

5. Poultry Farming

The term 'poultry' includes fowls, ducks,

geese, turkeys, guinea-fowls and pigeons, but is more often used for fowls. Keeping fowls for eggs, raising broilers for meat, poultry breeding and hatcheries are the common poultry enterprises. Poultry has been in vogue in India for over 5,000 years but most of the world's scientific knowledges of poultry husbandry has resulted from researches done within the past 75 years or so.

Poultry for egg production was at one time a minor village enterprise. Chickens or other fowls were kept either as a hobby or a few *desi* birds were kept to help pay for small household expenses. Only occasionally people consumed some poultry or egg.

Due to rapid urbanization and industrialization, the demand for eggs and chicken in the country has increased rapidly and the poultry farming has become a major agricultural enterprise of economic importance. Some of the factors favourable for the growth of poultry farming are: rather small initial investment, quick return, requirement of small area and use of various kinds of by products unfit for human consumption as feed stuffs. Poultry is India's most efficient converter of low fibre food stuffs (not used for human consumption) into highly nutritious animal protein food.

Besides, cropfailures, due to unfavourable weather conditions are common in India, but poultry raising is practically not affected by these factors. The losses are generally not associated with droughts or floods. Poultry farming readily adapts itself to a full time or part time occupation and proves profitable during the periods when no work is available to the farmer. It is the best enterprise for women, children and elderly people.

Poultry may be considered a soil building enterprise. The poultry manure is higher in nitrogen and phosphorous than manure from other livestock. Poultry birds produce about twice the quantity of fresh dropping (on a wet weight basis) than the feed eaten. A laying hen produces about 227 gm of fresh dropping (75 per cent moisture content) daily. When applied fresh it increases the moisture holding capacity of the soil. Poultry manure is also a good mulch. Poultry manure can be sundried, crushed into fine powder and sold in bags as an excellent fertilizer and mulch for lawns, flowers, shrubbery and field crops. Poultry litter also may be converted to compost litter and used as animal feed. It has been estimated that farmers can save Rs 1,000 per tonne of concentrate mixture by using poultry litter as animal feed at present rates of concentrate mixtures.

The importance of poultry is increasing day by day in the mixed farming system. Apart from the traditional combination of rice-poultry farming, certain new combinations like poultry-fish and poultry-pig farming are becoming popular which will help in establishing the income of small

farmers. The waste excreted by poultry is a very cost efficient input of fish production. It has been estimated that 1,500 birds (ducks) can excrete enough waste for the production of 6 metric tonnes of fish/hectare/year.

II. FISHERIES AND FISH SEED PRODUCTION

Fishes are cold-blooded aquatic animals which play an important role in diet of many Asiatic people. More than 50 per cent of the animal protein in the diet of Asian people is supplied by fish. The total fish production in India is approx 28.54 lakh tonnes and more than 5 crore people are employed directly or indirectly in fishing industry. Fishes and fish products earn foreign exchange to the tune of Rs 4,00 crore annually.

The fishery resources can be grouped under two braod categories viz. marine and inland including estuarine.

1. Marine Fisheries

India has an extensive coast-line along the mainland and occupies a pre-eminent position in marine fish production. The marine fisheries of India comprise varied species of fish and crustaceans. There are several ancillary resources, such as molluscs, enchinoderms, and seaweed.

2. Inland Fisheries

As against marine fishery, which is almost exclusively a capture fishery, the inland

fisheries can be divided into capture fishery and culture fishery, the latter being most important and highly rewarding.

The innumerable tanks, ponds, reser-

Fish culture under mixed farming can generate extra income to the farmer.

voirs and other similar water areas offer excellent scope for the development of culture fisheries in India. The indigenous species of carps (also called major carps) like catla (*Catla catla*) rohu (*Labeo rohita*), mrigal (*Cirthinus mrigala*) and Calbasu (*Labeo calbasu*) are commonly cultured in India. To a lesser extent a few exotic species like silver carp (*Hypophthalmychthya molitrix*) grass carp (*Ctenopharyngodon idella*) and the common carp (*Cyprinus carpio*) are also cultivated. The major problem in cultivating the major Indian Chinese carps is the non-availability of seed of these species for ready stocking in fish ponds because they do not breed in confined waters even though they mature in these water bodies.

FISH SEED PRODUCTION

The carp culture is gaining popularity in the country. As a result the need to ensure a dependable source of quality fish seed has been felt. The studies have shown that the sex-stimulating harmones of pituitary gland play an important role in the development and maturation of gonads and spawning in fishes*. The fish seed production can be divided into following three steps:

1. fish breeding;
2. recovery of fry or spawn from eggs;
3. recovery of fingerlings from fry or spawn.

1. Fish Breeding

An adequate stock of good brood fish is the basic requirement of induced fish breeding by hypophysation. Carps 2-4 years old and weighing 2-5 kg are the best. These are stocked in brood fish ponds suitably manured to produce natural feed. When the brood fish (both males and females) have reached sexual maturity they are separated and kept inside the breeding hapa. Generally two males are selected with a female. The pituitary glands are collected from the donor fish which are mature or nearing full maturity. The carps themselves would serve as proper donor fishes. These glands can be preserved in absolute alcohal or acetone and stored. The extract of these glands is injected to the brooders during the breeding season. Generally two doses to the female and one dose to the male are given. The quantity of the gland is decided by the weight of the fish. The injection may be given either in peritoneal cavity (intraperitoneal injection) or in the back muscle (intramuscular). The injected fishes are soon put back inside the breeding hapas and the mouth of the hapa

* Alternatives to pituitary are being developed. Human chorionic gonadotropin known by the trade name "Sumach" an indigenous product available on a commercial scale is being used increasingly, either in isolation or in combination with pituitary.

is securely closed to prevent escape of injected brood fishes in the pond. The brood fishes after a few hours of final injection begin to breed inside the breeding hapas. The female lays eggs which are fertilized by milt released by the males. Good fertilized eggs are transparent and they exhibit blastodisc and subsequent developmental stages.

2. Recovery of Fries from Eggs

The fertilized eggs are collected from the breeding hapa and kept in the hatching hapa. Two hapas are used for the recovery of fries from the eggs. One outer hapa made of markin cloth and the inner hapa made of mosquito net. The outer hapa is generally 2m x 1m x1m in size while the inner hapa is1m x 0.5m x0.5m in dimension. The outer hapa is open from the top and more than half of it is immersed in water. The outer hapa is fixed first and then the inner hapa. About 50,000-60,000 eggs are collected in some container from the breeding hapa and poured into the inner hapa. Only 4"-6" of the inner hapa is immersed in water. Enough care has to be taken on the maintenance of favourable temperature (26-31°) and sufficient supply of oxygen in the inner hapa. This can be done by frequent supply of fresh water. The eggs hatch out in about 14-18 hours after fertilization and fries come in the outer hapa, where they are left for 3 days. The unfertilized eggs and egg shell remain in the inner hapa which is removed after hatching is over.

3. Recovery of Fingerlings from Fries

On the third day after hatching, the young fries are collected and stocked in the nursery ponds. The nursery pond should be cleared of weeds, miscellaneous fishes, insects and other enemies of young fry. It should be manured properly so as to produce natural food, preferably the zooplankton in large numbers, which form the main food of young fry Artificial food in the form of finely powdered oil cake (groundnut) and rice polish or bran in 1:1 ratio may be given daily after the fries are released in the pond. The artificial food is increased continuously according to the body weight. In the first week it is 4-5 times of body weight which is increased to 8 times in the second week. The nursery ponds are usually netted out after 2 weeks of stocking and the advanced fries are restocked in combination with compatible species for fingerling rearing.

FISH IN MIXED FARMING

Certain species of fish are very good for mixed farming. There are now several methods of successful rearing of fish together with rice cultivation under a wide range of land conditions. If the method used is suitable for local conditions, it provides a large harvest both of fish and

rice. Fish in rice fields also improves soil fertility and soil structure. Experiments on paddy and fish culture have resulted in yields of about one tonne of fish and five tonnes of paddy per hectare in two crops.

The rice bran is cheap, energy rich, supplementary feed popularly used to significantly increase fish production. It has been worked out that there can be upto 169 per cent economic return increased fish production from the use of rice bran.

Poultry-fish and pig-fish farming are the other combinations which have a good potential. The waste excreted either by ducks/poultry or swine provide a very cost effective means of fish production and at the same time utilize paddy lands properly.

III. SERICULTURE

Sericulture – Rearing of silk worms for the production of silk is known as sericulture, it is a labour intensive agro-industry. Presently, China ranks first in production of mulberry silk, India ranks second followed by Japan, USSR, South Korea, Brazil etc.

In India nearly 52,000 villages are engaged in sericulture generating employment for nearly 62 lakh people directly and indirectly, next to the handloom industry. Sericulture is an export oriented sector of the economy with annual foreign exchange earnings of above Rs 255 crore.

Sericulture can be broadly classified into two distinct sectors viz. mulberry and non-mulberry.

In non-mulberry silk there are three types viz. Tasar silk, Eri silk and Muga silk. Much importance and scope is attributed to mulberry silk sector.

The most important consideration is the effective utilization of family labour, particulrly the aged, handicapped illiterate and women folk. One hectare of mulberry generates remunerative employment to 12 to 13 persons throughout the years. Sericulture plays a significant role in the distribution of wealth from rich class to the poor sections of the society. Silk is mostly consumed by the rich class and its monetary value is distributed among the farmers, reelers, twisters, weavers and traders.

Sericulture rightly fits in uplifting of socio-economic conditions of rural folk and can serve as an effective tool for rural reconstruction, benefitting the weaker sections of the society.

Sericulture involves four distinct stages namely mulberry cultivation, silk worm rearing, reeling and weaving.

Mulberry is generally cultivated under irrigated condition, but a hardy plant it can be raised under rainfed conditions with minimum rainfall of 5,00 mm. It is a perennial plant with short generation period.

Establishment and maintenance of mulberry gardens is easy and requires low investment. Silk worm rearing, for

conversion of mulberry leaf into the silk cocoons is simple and does not require high technical experience. The silk worm crop is of short duration and assures periodic income. The produce has a ready market and fetches higher income over other cash crops.

Though at present 35 countries produce silk their combined production makes up only 62,381 metric tonnes of raw silk per annum. It is very negligible, when compared to the other natural fibres and man made fibres. Practically nothing is wasted in silk industry. The mulberry stems serve as a source of fuel, the left over leaf as a good cattle feed, the litter for bio-gas production, reeled out pupa as poultry, cattle feed and silk waste for spun silk industry.

Mulberry can be successfully grown as an inter crop between the rows of tea/coffee plants as shade plant. By this, besides providing shade to the tea/coffee plants, a good quantity of quality leaves can be obtained for silk worm rearing resulting in additional income from a unit area.

Mulberry has been found to be a promising inter crop. It can be successfully cultivated in the wider space between the rows of coconut trees as practised in different parts of south Karnataka State. Apart from this, Amaranthus and other leafy vegetables, radish, beans, onion, garlic, carrot etc. can also be cultivated as inter crop in mulberry gardens.

In view of the above, since sericultural industry is sharing all the features and basic requirements in common with agricultural industry, it is needless to say that it is an agro-based industry. Particularly in Kolar district of Karnataka, almost all the silk worm rearers have dairy cattle so that 'Milk and Silk' go together there by causing the "White Revolution". However, sericulture industry would have come up as a more effective industry, if proper organization, seed production, control of diseases and uzifly menace are taken care of.

Thus, sericulture is one of the most potential components of mixed farming in India. It is pleasantly not uncommon to see, inter alia, 'Silk with Milk' in one and the same farm stead.

IV. APICULTURE

The rearing of honey-bees for the production of honey and wax is known as apiculture. It was in the nineteenth century that bee keeping as a result of scientific research, became a commercial proposition. Studies threw new light on the biology and behaviour of bees. These findings formed the basis of the bee management which has been undergoing modifications from time to time.

Bee-keeping provides an ideal subsidiary occupation with very little effort and expenditure. Honey-bees produce nutritious honey and valuable wax. Beside the direct advantages, bees pollinate vegetable, fruit and field crops, thus in-

creasing the yield. At cold places, the pistils are liable to be destroyed by frost unless quickly fertilized. The presence of a large force of bees at the right time ensures their rapid fertilization and a heavier crop through better fruit set. Many varieties of almond, apple, pear, plum and sweet cherry cannot set fruit with other own pollen. The honey-bees being under the control of man can be utilized for pollination with great ease and advantage. Yield of Brasica and clovers is increased manyfold if beehives are kept near or in these fields during flowering. This is also true in regard to berries of all kinds and several vegetable crops such as radish, turnip and cabbage when these are grown for seed.

Five species of honey-bees are found in India. These are *Apis dorsata, Apis cerana-indica, Apis florea, Melpona sp.* and *Trigona sp.* True honey-bees belong to the genus Apis.

The species of *Melipona* and *Trigona* are about the size of gnats and possess no sting. *Apis dorsata* (Rock bee or Giant bee) and *Apis florea* (*Chhoti Makhi* or little bee) are not important commercially. However, these are good pollinators for crops having small flower. From commercial point of view *Apis cerana-indica* is most important and can be maintained in hives.

The honey-bees are of three categories viz. queen, workers and drones. The first two are female while the drones are males. In the workers the ovaries do not develop and they therefore are unable to lay eggs. Only the queen is capable of laying eggs and is the mother of the entire colony. It lays two types of eggs, viz. fertilized and unfertilized. The fertilized eggs give rise to the workers and the queen, while the unfertilized eggs develop into the males. The quantity and quality of food given at the larval stage decides whether a fertilized egg will develop into a queen or a worker. The honey-bees can be reared in colonies maintained in the artificial hives. An apiculturist has to perform several operations like shifting the bee-hives to the sites where suitable flora is available, feeding the bees during lean period, protection from natural calamities etc. One queen is sufficient in a colony and it is the only perfect female which never mates again if it has started laying eggs. A colony is doomed if it is without queen. During February-March and November-December when nectar is abundant, new queens are allowed to be reared.

The equipment needed for bee keeping are stand, hive tool, bee veil, bee hand gloves, smoker, comb foundation, wire embeded-wiring board, uncapping knife, honey extractor, feeder, queen excluder, queen gate, queen introducing cage, drone trap, queen wing clipping scissor, queen cell protector, bee escape, carrying cage, honey storage tank, uncapping tray, nucleus hive, division board, cover netting etc.

Swarming, in which the queen leaves the hive with a portion of workers and drones during the major honey flow season should be prevented. It can be done by removing additional queen cells and drone cells and clipping the wings of the queen.

There are a number of diseases affecting the bees, but 'Sac Brood' is the most disastrous. It is a viral disease and there is no drug to cure the diseased brood. The disease can be checked by destroying the infected colonies and preventing the movement of bees to infected colonies.

V. MUSHROOM CULTIVATION

Mushrooms are higher forms of fungi which can be grown easily on agricultural wastes. Their fruit bodies are fleshy, palatable and rich in nutrients and hence they assume a great importance as a value of dietary article. The protein content in mushrooms is twice as high as in most vegetables except green peas. Besides quantity the quality of protein is of high value with the presence of all essential amino acids especially lycine and tryptophan which are not found in any other vegetable sources and are found only in animal protein sources. Starch content is very low, but the starch present is of high quality i.e. in the form of glycogen which is easily assimiable in human body. Mushrooms are rich in vitamins and minerals. Presence of higher percentage of potassium and low percentage of sodium makes them ideal food for people with abnormal blood pressure. Sugar content is very low and are deficient in chlosterol and hence mushrooms are ideal for diabetic patients also.

Because of these reasons mushrooms occupy an important place in vegetarian diets of the world. Mushroom cultivation and consumption if spread to the rural areas will greatly help improving the income, health and general economy of the farmers. As mushroom cultivation could be done under closed structures such as thatched huts, it does not compete with agricultural land. Mushroom cultivation makes a highly practical and useful component of mixed farming.

There are several genera of cultivated mushrooms, but commercially *Agaricus bisporus* (white button mushrooms), *Volvariella volvaceae* or cheese mushroom and *pleurotus* species or oyster mushroom are the most important cultivated mushroom. Cultivation of *Agaricus* or button mushroom can be taken up on synthetic compost at 15-20°C which is the most ideal temperature for its growth. So it can be grown during the winter season in Northern India.

The other two types of mushrooms which are recommended for cultivation with simple techniques are oyster mushroom or Dhingri (*Pleurotus* spp.) and the paddy straw mushroom (*Volvariella* spp.). These two can withstand a higher temperature 25-30°C and more suited to

tropical conditions prevalent in South India.

Different steps in cultivating mushroom are:

(i) composting;
(ii) bedding;
(iii) spawning;
(iv) casing;
(v) cropping.

The following things are essential for starting mushroom cultivation:

(i) spawn;
(ii) suitable medium (straw, compost);
(iii) mushroom house;
(iv) suitable market.

Spawn or seeds are available from most agricultural universities and training for mushroom cultivation can be got from these universities.

VI. SILVIPASTURE

India is already short of forage production for the country's bovine population. This is a type of crop husbandry in which forage is produced from the traditional forage crops as well as from certain multi-use trees/bushes by including the forage plants in the well established grain crop rotation in the farmers fields. The share of silvipasture in a mixed farm can vary depended upon the soil properties, irrigation facilities and requirements of the farmer.

Under silvipasture forage grasses and legumes are grown in interspaces of systematic tree plantation. The trees should be hard and fast growing and should also be fodder-cum-fuel, fodder-cum-green manuring or fodder-cum-gum type with tolerance to lopping. There should be a good compatibility between the grasses and the trees selected for this purpose. These should also have a quick generative capacity and ability to propogate vegetatively as well as through seed. Subabool (*Leuceana leucocephala*) Shevri (*Sesbania aegyptica*) Augasthi (*Sesbania grandiflora*) and some species of *Acacia* and *Abezza* have been found suitable for this purpose. However, these should be selected keeping into consideration the topography, climate, land type and water facilities of the farm stead.

When the forage trees are grown along with food grain crops this is known as Agro Silvipasture'. Crops like wheat, sorghum and maize etc. can be taken up with these trees under irrigated conditions while sesame, barley, small millets etc. can be taken up under unirrigated conditions. The distance between two rows of trees/bushes is maintained at 3-4 meters. During growth, the lower branches are prunned frequently and the main shoot is allowed to grow. At a height of 2 or 1.5 meters, its canopy is maintained and manipulated at harvest to allow penetration of light for the associated crop.

Silvipasture is very good for the utilization of waste land, marginal and hill lands

for forage production. It is also good for the areas with water scarcity, where land remains fallow during most part of the year. The introduction of these multi-use-forage-cum-fuel trees/bushes will not only help in checking erosion but will also provide protein-rich fodder, to the animals, wood for fuel and raw material to the industries besides acting as wind breaker.

CHAPTER 3

Agro-Based Industries

The preceding pages have given us a fairly good idea about the vast scope of agriculture and incredible diversity of its activities. Therefore, it is but natural that the industries using agricultural products and by products as raw materials are equally diverse in their nature. Some are just the primary processing industries which produce simple agricultural products using relatively simpler technologies like crushing, grinding, compacting, polishing, mixing etc. Their examples are rice, dal and flour mills, animal feeds manufacturing units, hay-fodder production farms, natural fibre production spices and condiments processing etc. Other agro-based industries make use of complex technologies to produce a variety of products from the primary agricultural raw materials for example; extraction of oil from soyabean seeds, preparation of beverages, vinegars, alcohols, jams, jellies, preserves etc. from fruit and vegetables, preparation of milk products, pork products and so on.

Agriculture provides raw material for the food processing industry involving simple primary as well as advanced technologies.

Here we will review some of the interesting agro-based industries with adequate details of their basic initial constituents.

I. CONDIMENTS AND SPICES

India is rightly famous all over the world as the "Home of Spices" where about 63 spices and condiments are grown under different soil and climatic conditions. India annually produces over two million tonnes of different spices valued at about

Rs 3,500 crores. Spices are good foreign exchange earners for the country through their export to different parts of the world. They are exported as such in raw form after primary processing or made into various types of mixtures, powders or extracts.

The spices and condiments are used in food and medicine because of their essential oil contents, taste and aromatic properties. Important among spices are pepper, cardamom, ginger, turmeric, chilli, garlic, coriander, cumin, fennel, fenugreek, celery, saffron, clove, nutmeg and cinnammon. Pepper is the most important spice in terms of quantity and value realized. Cardamom, ginger, turmeric, clove, nutmeg are the other important spices earning foreign exchange. Saffron is the costliest spice on earth and in India its cultivation is confined mainly to the Kashmir valley. Seed spices like corriander, cumin, fennel, fenugreek, celery are comparatively minor exchange earners. Important value added products from spices are oils, oleoresins and curry powder. Curry powder industry is receiving much attention these days and its export has increased to 3,000 tonnes annually and there is scope for further growth.

The major spice oils exported are pepper oil, ginger oil, clove oil, cardamom oil etc. Spices and condiments involve three distinct economic activities viz. their production, processing and marketing. Here are some of these crops:

1. Cardamom (Elettaria cardanomum (L) Maton.)

It is a plantation crop grown under natural conditions of tropical forest on slopy lands with good drainage. Loam and lateritic soils having 150 cm annual rainfall suit the crop which grows best at 10-35°C temperature. The yield constitute of dry capsule 1.5 to 2.9 t/ha. Capsules are cured and stored in polythene lined bags before marketing.

2. Pepper (Piper nigrum L.)

Commonly called Kali-mirch is a perennial climbing vine. It grows in humid tropics on well drained clay loam soil rich in humus and requires warm humid climate with 250cm rainfall and requires 14-40°C temperature. Fruits take 6-8 months to mature which are used after curing.

3. Chillies (Capsicum annuum L.)

It is commonly called red pepper and widely used for chutnies and pickles due to its pungency. An alkaliod "Capsicin" is obtained from chillies. Chillies grow better on well drained black cotton soil as well as on light alluvial loamy and red loamy soils under both irrigated and rainfed conditions. The yield varies from 500 kg, to 10-20 q./ha depending upon the cultivation conditions.

4. Ginger (Zingiber officinale Rose)

It is commonly called "Adrak" whose rhi-

zomes grow well under partial shade in deep well drained friable loamy soils rich in humus. Average yield 10-30 q./ha. Rhizomes are used in fresh raw form or they are cured and dried for medicinal and culinary purposes. Ginger oil and ginger extract are also obtained from the rhizomes.

5. Turmeric (Curcuma longa L.)

Commonly known as "Haldi" and is widely used as drug, dye, stimulant, spice and cosmetic. A special type of starch is also obtained from turmeric. It grows well in warm and humid climate on well drained fertile, sandy, clayey, alluvial loam soils. Rhizomes are cured and dried after their maturity. Average yield about 15-17 q./ha. Recovery of cured from the raw produce 20-25 per cent.

II. MEDICINAL PLANTS

Medicinal and aromatic plants form a numerically large group of economically important plants which provide basic raw materials. Medicinal plants for the indigenous pharmaceutical, flavour and cosmetic industries help the country to earn foreign exchange.

The curative properties of drugs are due to the presence of complex chemical substances of varied composition in one or more parts of these plants. The plant metabolites according to their composition are grouped as alkaloids, glycosides, cortico steroids, essential oils etc. Some of the important medicinal plants are:

1. Opium poppy

(Papaver Somniferum)

It is an important medicinal plant of India which is the main source of opium and opium alkaloids, such as morphine, codeine, thebaine and papverine widely used in modern pharmaceutical preparations. Poppy is grown mainly in Uttar Pradesh, Madhya Pradesh and Rajasthan. India is the largest and only legal producer of opium.

2. Sapogenin Bearing Yams

Various species of *Discoriea*, often refered to as sapogenin bearing yams, are among the most important medicinal plants in terms of economic value throughout the world. The tubers contain diosgenine, the basic raw material for synthesis of steroidal drugs. These yams also provide raw material for industrial production of corticosteroids including cortisone used for treating large number of ailments. Most of the steroidal drugs in India are now being produced from rhizome of *Dioscorea deltoidea* collected from the forests of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh.

3. Psyllium (Isabgol)

India is the major producer and supplier of Psyllium seeds and husk to the world market. Isabgol based drugs have gained increasing popularity in India and abroad.

Infusions and decoctions of whole seed and husk are used as bulk laxatives. It overcomes chronic diarrhoea and dysentery. It is mainly grown in Gujarat and the adjoining areas of Rajasthan.

4. Cinchona

Dried bark of stem and roots of cinchona species are the sources of over 25 alkaloids. The most important being Quinine, Quinidine, Cinchonine and Cinchonidine. Quinine is mainly used as suppressive anti-malaria drug. It is also used as flavouring agent in soft drinks. There is ample scope to cultivate and process cinchona bark for its alkaloids. Cinchona is mainly grown in Northern West Bengal and hills of Tamil Nadu.

5. Mints

Mint oil, obtained by steam distillation of the whole herb of *Mentha arvensis* is the best source of natural menthol with its wide use in pharmaceutical and flavour industries. Kitchen garden mint, or pudina (*Mentha viridis*) is grown mainly for flavouring domestic culinary preparations and is also used in pharmaceutical and cosmetic industries.

6. Belladonna (Atropa Belladonna)

The leaves and roots of belladona constitute the commercial drug which contain atropine, hyoseyaminek and nyocine used for their mydratic, analgesic and antispasmodic properties.

7. Rouwolfia (Rauwolfia Serpentina Benth)

It contain 55 alkaloids including reserpine which is the most important. The root powder or other preparations containing its alkaloids are prescribed in treatment of high blood pressure, insomnia, and certain forms of insanity.

8. Lemongrass (Cymbopgon flexuosus Stapf)

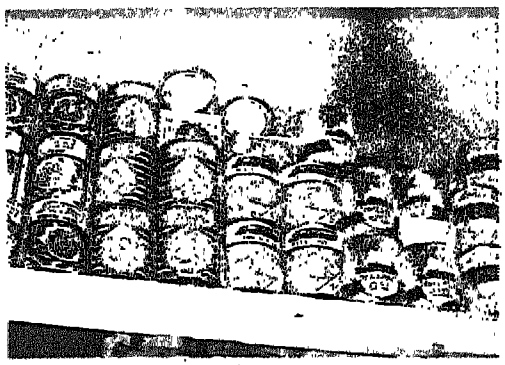
It is a stemless perennial grass whose leaves yield an aromatic oil containing 75-85 per cent citral. The oil is used in perfumery, confectionery, soap industry, cosmetics etc.

9. Palmarosa (Cymbopogon Martinii var. motia Stapf)

It is a tall perennial grass with flowering top and foliage containing a sweet smelling oil which emits a rose-like odour. It is widely used in soap, cosmetics and perfumery industries in addition to medicines.

III. PRESERVATION OF FRUITS AND VEGETABLES

Fruits and vegetables have gained considerable commercial importance all over the world, contributing significantly to the economics of many countries including India. Being seasonal, these commodities are available in abundance mainly during their respective harvesting period. Fruits and vegetables after harvesting start dete-



Food preservation opens a new direction for cultivation of different fruits and vegetables.

rioration through physiological process combined with deleterious activity of micro organisms. They can be kept for long time without significant deterioration if both these processes are checked. There are different methods of preserving them viz., canning, freezing, drying, fermentation and use of chemical preservatives; i.e. sugars, salts, spices etc. Out of these preservation methods, use of chemical preservatives, sugar, salt and vinegar is relatively simpler and easily practicable.

Most common products prepared through preservation of fruits and vegetables are:

(i) squashes;
(ii) cordials;
(iii) ketchup;
(iv) jam;
(v) jellies;
(vi) marmalades.

Squashes, contain 25 per cent of fruit juice with 60 per cent sugar. The cordial has 25 per cent juice content with a sparkling finish because the juice is clarified. We can have fruits for our table everyday in the form of jams, jellies and marmalades. Jam is a product having a firm gel consistency. It is made of fruit pulp or juice. Fruit jelly is a semi solid gel prepared from the filtered extract of fruits boiled in water. It is a clear transluscent product having no fruit pulp. Marmalade is generally made from citrus fruits. It could be a jam or jelly type. Peel of the fruit is added in this case. Fruits and vegetables can also be preserved by turning them into preserves crystallised and glazed fruits i.e., the fruit or vegetable pieces are preserved by a syrup of high sugar concentrate. Fruits can also be preserved by sun drying and dehydration.

A review of the product pattern during last five years indicates a two fold rise of production of fruit pulp, fruit based drinks and jam groups of products. Fruit juice concentrates are the base materials for fruit beverages. Now a days, there is gradual shift from soft aerated drinks to fruit based soft beverages. This has created new opportunities in the export market for fruit beverage bases like pulps and concentrates. Other fruit products gaining very great importance in the market are fruit bars (mango, guava, apple), fruit toffee, conventional glazed fruits, murabba and preserves. Preparation of fruit powder is also another feature

in recent years.

Tomato products including ketchup, sauce and paste have come to stay as important items in domestic market. Pickling industry is also gaining potential importance throughout the world. Major fruits used for making pickles are mango, lemon, chilli, ginger etc.

IV. SUGAR, *KHANDSARI* ALCOHOL

Sugarcane and sugarbeet are two main crops that contribute approximately 56 and 44 per cent respectively of the total sugar production in the world. Sugarcane *(Saccharum officenarum* L*)* is the main source of sugar in India and holds a prominent position among cash crops. India is the only country where sugarcane is used as raw material on a large scale for different purposes i.e., for production of white sugar, *gur* (jaggery) and *khandsari*. Two important by products which indirectly contribute to a reduction in the cost of sugar are molasses and bagasse. Molasses is used in the alcohol industry. A new development is the use of bagasse for making paper and even rayon besides building boards. Alcohol or wine is a fermentation product of surgery materials chiefly the molasses from sugar industry. Carbohydrates of these products are converted to alcohol by the action of enzymes produced by yeast *(Saccharomyces ellipsoideus)* added for fermentation. Fermentation is a chain reaction carried out by micro-organisms. The alcohol produced in above reaction if not expelled is further acted upon by bacteria which convert the product into vinegar (acetic acid). Special type of fermentation chambers are used for filling the raw materials viz., juice, *gur*, molasses, ripe grapes, etc. Several types of liquors are obtained by fermentation of juice from palm tree (neera), from rice (sake), from cashew or coconut (fenny).

Vinegar (5 per cent acetic acid) is also another product that is obtained from molasses, low grade honey, cane juice, fruits like grapes, apple, oranges etc. after alcoholic fermentation.

V. VEGETABLE OILS, GRAINS AND PULSES

Major oil yielding crops are sesamum, mustard, sunflower, coconut, soyabean, safflower, groundnut, castor, olive etc. There are two types of oils: edible and non edible. Edible oil commonly used for human consumptions are:

Ground nut oil – extracted from *Arachis hypogaea* Linn.
Coconut oil – extracted from *Cocos nucifera*
Palm oil – extracted from *Elaeis guineensis* Jacg
Gingellie oil – extracted from *Sesamum orientale*
Mustard oil – extracted from *Brassica* sp.
Sunflower oil – extracted from *Helian-*

thus annuus Linn

Non edible oil usually used in various industries are:

Castor oil – extracted from *Ricinus communis* Linn

Olive oil – extracted from *Olea Europia* Linn

Cotton seed oil – extracted from *Gossypium* sp.

Linseed oil – extracted from *Linum usitatissiumum.*

Another group of vegetable oils represents the essential oils e.g. perfume oils:

Sandal wood oil – extracted from *Santalum album*

Lemon grass oil – extracted from *Cymbopogon citratus*

Rose oil – extracted from *Rosa demaseena*

Spices and flavouring oils – extracted from various spices and aromatic plants

Vanilla – extracted from *Vanila planifolia*

Nutmug oil – extracted from *Myristicos fragrans*

Clove oil – extracted from *Eugenia caryophyllata*

Cinnamon oil – extracted from *Cinnamomum zeylanicum*

Cardamom oil – extracted from *Elettaria cardamomum*

Medicinal and Industrial oils – extracted from various plants

Eucalyptus oil – extracted from *Eucalyptus citriodora*

Camphor oil – extracted from *Cinnamomum camphora*

Among vegetable oils importance has to be given to the copra industry. Copra crushing is an important traditional industry in all coconut growing areas. Copra is the dried coconut and it is mainly of two types – milling copra and edible copra.

Grains like wheat, rice, and maize are processed in factories to produce different products. *Maida*, *suji* and *dalia* from wheat and *poha*, *murmura* and *chiwda* from rice and maize are some of the products popularly manufactured in factories. For *maida*, *suji* and *dalia* preparations wheat grains are subjected to some treatment, for removal of fibrous material by soak treatment, drying and flouring employing different sieves. Similar processes are also applied for paddy to obtain *poha*, *murmura* and *chiwda*. The rice grian is subjected to soaking and dry heat, treatment which convert the grain in different forms. These are then further polished, processed and graded before packing.

The term pulse is used generally for seeds of leguminous plants which are used as food. The common pulses are:

Red gram (Arhar) – *Cajanus cajan*

Bengal gram – *Cicer arietinum* L.

Black gram – *Phaseolus mungo* L.

Green gram – *Phaseolus aureus* roxb.

Indian cowpea – Vigna catjang walp
Field bean – Dolichos *lab lab.*

The grains are soaked in water, dried and then processed to make *dal.* After polishing and grading the *dal* is packed in bags for marketing.

VI. POULTRY AND ANIMAL FEEDS

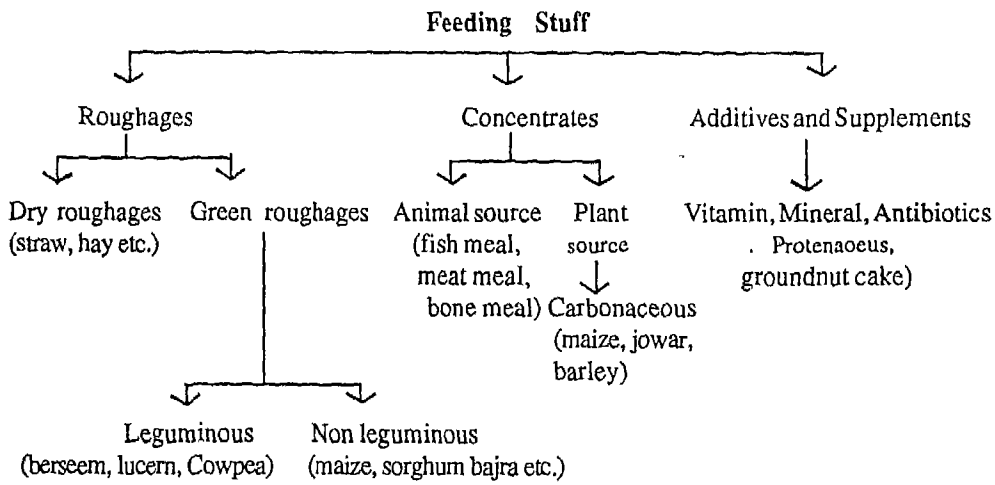
There are different types of feeding stuffs available for the livestock and poultry feeding. Broadly the feeding stuffs can be classified as:

(i) roughages;
(ii) concentrates;
(iii) additives.

Roughages are the feeding stuff which are bulky and contain more than 18 per cent crude fibre. They contain low concentrations of energy yielding articles e.g. straw, green fodder, silage etc. Concentrates are less bulky, have less crude fibre and are rich in energy yielding nutrients for example cereal grains, oilseeds and their byproducts.

Additives include vitamins, minerals, antibiotics, preservatives, fillers or buffers which are added to the feeding stuff as per needs of the animals. The additives are usually added in very minute quantities following the required proportions. The additives influence definite physiological activities of the animals, increase digestibility of food nutrients, have therapeutic effects and make the feed more palatable.

The poultry feed is prepared in different grades for feeding at different stages of the growth of birds viz., chickling, growing bird, laying bird and for broilers. Materials like maize, husk and bran of rice, gram and pulses are first made to powder and then mixed with each other in different proportions. This basic lot is then enriched by adding mineral salt, vitamins and some preservatives.



Similarly, feeds for different animals like cows, bullocks, buffaloes, goats, sheep, pigs, horses, fish are prepared as per specific requirements by blending different components in various proportions. Farm waste materials can also be incorporated in different feeds, thus reducing the cost of their production without lowering the quality and nutritve values.

Feed is generally the costliest input of any branch of animal husbandry. There is ample scope for the farmers to make best use of the farm produce for profitable production of animal feeds for local consumption as well as for sale to others.

VII. FIBRE INDUSTRY

Since times immemorial the man has learnt the art of extracting natural fibres from various plants and putting them to most diverse uses. A large number of fibre yielding plants have been brought under cultivation as cash crops which provide raw material for the gigantic fibre industry. Some of the important fibre crops of the Country are briefly described below:

1. Cotton (Gossypium sps.)

Large number of varieties and hybrids of indigenous as well as exotic cotton are grown in the country. Although India has the largest area under cotton in the world, the yield per hectare is quite low. Radical agronomic and other measures are imperative to increase cotton production in the country.

2. Jute (Corchorus sps.)

Mainly two species *capsularis* or white jute and *olitorious* or 'tossa' jute are grown on loamy alluvial soils under hot and humid climatic conditions. It is a more labour intensive crop (270-300 mandays) than cereal crops like paddy (150-170 mandays). The fibre is used for the manufacture of a variety of goods like gunny bags, sackings, ropes, carpet backings etc.

3. Flax (Linum Usitatissimum)

The fibre is valued for its strength, durability, softness, shining and high water absorbancy. It is used for linen stiching, making twines and fishing nets, carpet backings, house furnishing. It is a good raw material for making tissue paper, water bags, hose pipes etc.

4. Sisal (Agave Sisalana)

Fibre is extracted from the leaves of the perennial plants to make ropes, matresses, brushes, mats and other fancy items. Although its commercial cultivation is mostly confined to poor soils under rainfed conditions.

5. Ramie (Boemeria Nivea)

This rhizome propagated plant grows well in areas of high rainfall and warm humid climate to yield valuable fibre for textile industry. The fibre blends well

with synthetic yarn like nylon, rayon. It can be spun and woven into excellent cloth that can be dyed in variety of brilliant colours.

6. Coconut (Cocos Nucifera)

The fibre, known as coir, is used for various industrial purposes like making ropes, mats, rubberized matresses, nets, bags etc.

7. Sunhemp (Crotalaria Uncea)

It yields dull yellow, somewhat coarse, and strong fibre used for making ropes, canvas, mats and variety of fancy items, besids being a good raw material for manufacture of tissue and currency papers.

Many of the above mentioned natural fibres are blended with other man made materilas to produce a variety of items like woolenized fabrics, rubberized matresses, fishing nets and lines, marine and industrial ropes, twines, cardages, cables, heat and sound insulation materials, packing, backing, flooring and furnishing material etc.

Besides, agro-industries have in their fold such economically significant industries like:

(i) rubber industry (based on the latex from *Hevea brasiliensis* plant);
(ii) natural lac processing industry;
(iii) cashew processing industry;
(iv) beverages (based on the products from the tea (*Camellia thea*), Coffee (*Coffea arabica*) and Cocoa (*Theobroma coca*) plants;
(v) fumetories and Masticatories derived from the tobacco (*Nicotiana* spp.) plants and many others.

All these agro-industries have very interesting tales of their origin. For example, initially the cashewnut (*Anacardium occidental*) was widely planted to check soil erosion, but now cashewnut has become a major foreign exchange earner of the country. Cashewnut processing is a labour intensive industry. Apart from nuts, the cashew apple is also used for making an alcoholic drink 'feni' and several other products like syrup, juice concentrate, candies, jams and so on.

CHAPTER 4

Agriculture Economics

Today agriculture is not what it used to be a few centuries back. It has undergone sea changes with the passage of time. Far from being just a means of livelihood for our rural folk, it has transformed into a full-fledged enterprise involving complex production relations based on economic principles. The knowledge of these operative economic principles has become a necessity for farmers to maximise profits from the farms. Every farms operation and its utility is to be necessarily judged from the economic point of view. Hence, acquaintance with agriculture economics and its scope is not only interesting but also useful to all concerned with agriculture.

Economics is the study of human behaviour in relation to ends and scarce means having alternative uses. The ultimate outcome of any use should result in maximum satisfaction or gain. In case of agriculture this simple yet fundamental economic rule affects each and every farm operation through phenomena like cost of cultivation, capital investment, credit, loan, depreciation on assets, marketing, farm management and so on. Without going into detailed intricacies of economics, here we will consider some of the most important and crucial elements of agriculture economics which determine the efficient of any farm enterprise.

I. COST OF CULTIVATION

Cost in general refers to the expenses incurred on inputs. The cost of cultivation of a crop refers to the expenses incurred on various aspects of crop production. The knowledge of cost of cultivation of different crops is essential to government as well as farmers so that crop production is remunerative to farmers and the produce is within easy reach of average buyers. Because of fundamental importance of the cost of cultivation of crops, the concepts of working out it have been fairly standardized. The entire cost of cultivation is grouped into:

Cost A : Including expenses on hired labour male, female, seeds, manures and

revenue and other cesses, interest on working capital, rent on leased land, irrigation charges, artisans' charges and others.

Cost B: Including cost A plus interest on fixed capital plus rental value of the land.

Cost C : Including cost B plus imputed value of family labour (male and female).

Cost of cultivation of different crops is worked out by considering all the above parameters and the total farm produce. Then it is worked out per unit area of land separately for each crop. The value thus derived helps us to determine the selling price of the produce.

II. AGRICULTURAL CREDIT

In India 69 per cent cultivators are small and marginal cultivators whose income level is quite low. As a result of this they cannot make additional investment in cultivation. In ancient days agriculture was subsistence type and capital need was limited. Now agriculture has become more capital intensive. A large number of farmers are unable to invest in capital on their own. Hence, agriculture credit has become a must for rural development.

There is a strongly felt need for providing agriculture credit to farmers on a large scale and liberal terms. Many schemes for credit are operating today in our country. Agriculture cannot develop unless credit facilities are available to the farmers. The need for credit has become all technologies introduced in agriculture.

Credit Needs

The farmer needs credit for the following purposes:

(i) land and its improvement;
(ii) agricultural implements, machines and livestock;
(iii) requisite inputs such as seed, irrigation, fertilizer etc;
(iv) stocks of food and clothing to maintain the farmer and his family during the period of production.

Types of Credit

Agriculture credit extended to farmers is of three types:

(i) short term to purchase seeds, manure etc;
(ii) medium term to purchase cattle and implement;
(iii) long term finance for making permanent improvements in land etc.

Credit Agencies

The main agencies which supply credit to the agriculturists are professional agriculturist, money lenders, government cooperatives, commercial banks and miscellaneous sources consisting of traders, commission agents, land lords and relatives. The non-institutional private creditors

dominate rural credit. Cooperatives and government have until recently played an extremely insignificant role.

Private Agencies

The village money lender is still an important source of borrowing and even though sometimes he has proved to be a dangerous necessity he has been and still is an inescapable necessity. More than 70 per cent of the debt is owned to the professional money lenders. Village money lender is often the one thrifty persons amongst generally thriftless people and that his methods of business suit the happy-go-lucky way of the peasants. He is always accessible, even at night, dispenses with troublesome formalities, asks no inconvenient questions, advances promptly and if the interest is paid, does not press for the payment of the principal. He keeps in close touch with his clients and in any village shares their occasions of well and woe. And he not only finances his neighbours but frequently keeps small shop to supply peasant needs and is nearly always prepared to be involved in the circle which brings crop after crop to the threshing floor, and it is more than any one else who tides the peasant over a time of distress.

Co-operative Credit Societies

The rural credit societies were started to carry the business of the rural banking and replace the money lenders, yet they have not made any appreciable progress. The record of the co-operative credit has been very uneven as between different states. Even in the states, which have registered considerable progress, there are pockets where the performance of co-operative has been very poor and weak.

Government Credit

Government provides financial assistance by way of loans to farmers. The loan period, depending upon the type generally extends up to 25 years on the security of landed property. It is repayable in several easy instalments.

Co-operative Credit

The idea of using co-operation in India as a means of combating rural indebtedness and supplying credit was first suggested by Sir Frederic Nickolson in 1897. For this purpose, the first co-operative credit society's act was passed in 1904. Societies were started for carrying on business of rural banking and to replace the money lender. Inspite of more than 8 decades of efforts, the co-operatives have not been able to meet the needs of the farmers.

Commercial Banks

They also provides finance to peasants either through primary co-operative societies or directly. Considerable increase can be seen in the assistance provided by the commercial banks after their nation-

alisation. However, these banks have faced great difficulty in providing agricultural credit as the credit requirements of Indian agriculture has been mounting up year after year. The repayment of loans is extremely poor, usually between 20-30 per cent of the borrowings.

The 37 commercial banks, constitute an Agricultural Finance Cooperation with an authorised capital of Rs 100 crores. The objectives of the Corporation are to :

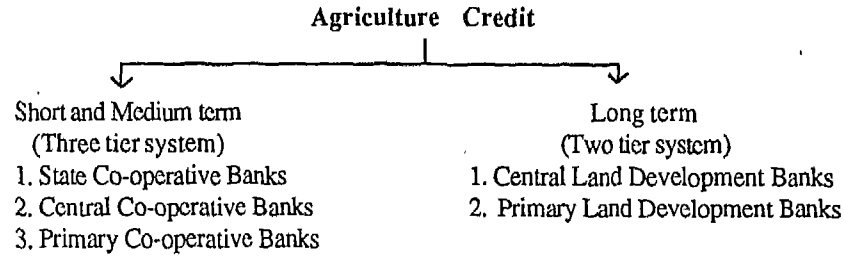
- provide short term and medium term credit for seed farms;
- provide medium term loans for mechanisation;
- finance vertical integration of processing industries units with agricultural production;
- finance construction of warehouses, godowns etc.

III. CO-OPERATIVE MOVEMENT

The idea of co-operation received support from the famine commission of 1901. In 1904 Indian co-operative societies Act has been passed. The act provides for the formation of credit co-operatives. Credit Societies with their simple organisation and method of management afforded an easy field in which the priciples of co-operation could be learned and practised.

By far the largest number of societies were in the agricultural credit sector. In 1980 there were more than 95,000 primary agricultural credit societies covering 96.5 per cent of the rural areas. The membership of these societies was 541.4 lakhs as on June 1980. The societies had a share capital amounting to Rs. 496.6 crores in 1980 and short-term agricultural lending amounting to Rs 969 crores during 1979-80.

The co-operative structure in India consists of two parts: one engaged in short term and medium term credit and other in long term credit. The former in each state is a three tier structure. The primary co-operative agricultural credit societies at the village form the base. They federate into central co-opearive banks, usually at the district level. At the state level these are federated into an apex bank serving an entire state. The apex bank in its turn is closely linked with the Reserve Bank of India (RBI). The long term credit is provided by a central land development bank for each state at the apex level. The apex



bank works through primary land development banks, each serving an area of a *taluk* or district and where there do not exit land development banks, through its own branches or central co-operative banks.

IV. CROP INSURANCE

Practically every year in one part of the country or other food crops affected by weather hazards. The magnitudes or risks and the uncertainties to which the farmer's fortunes are exposed are very large. The total loss due to natural calamities is estimated to be as high as Rs. 1,000 crores every year.

Need of Crop Insurance

The unsteadiness of weather conditions in different parts of the country upsets the whole agricultural economy. Farming is more hazardous than any other form of enterprise. The weather conditions can make all the difference between success and failure.

Advantages of Crop Insurance

(i) it provides protection to farmers against destruction;
(ii) it increases the credit worthiness of the farm;
(iii) it reduces to a great extent, the government relief expenditure extended to meet the havoc caused by natural calamities.

Nature of Crop Insurance

Crop insurance identifies loss or damage to crop resulting from a variety of causes such as hail storm, drought, frost, flood, fire and diseases. The farmers pay premium and protection is given to them on the same basis as in other insurances. When the protection from an insured acrage falls below the insured coverage, the farmer is entitled to an indentity. Coverage and premium rates are settled on the basis of productivity and susceptibility to risk of the land under cultivation the same area.

Crop Insurance in India

The idea of crop insurance in India was mooted about three decades ago when a sub-committee on land, agriculture labour and insurance area had recommended a national scheme of cattle and crop insurance was attempted in Madhya Pradesh in 1943. This scheme was compulsory and administered by a corporation.

In 1946 a crop insurance scheme was proposed by Dr Narayana Swamy Warier for Madras to help stabilize farm incomes. Complete failure of crop was compensated with upto 50 per cent of the crop value. In 1949 a pilot scheme has been submitted covering 4 crops viz. rice, wheat, cotton and sugarcane. In 1952 the four states of Bombay, Uttar Pradesh, Madhya Pradesh and Tamil Nadu con-

templated to launch crop insurance scheme for the benefit of the farmers.

V. SUBSIDIES FOR FARM INPUTS

Government often offers generous subsidies for various inputs. They can be on bank loans or other financial assistance for the peasants. Subsidy is given on inputs like seeds, fertilizers, plant protection chemicals, implements, irrigation and other implements.

The National Seeds Corporation supplies hybrid and improved seeds of various crops on subsidised price through various agencies. Seeds of vegetables, pulses, green manure crops etc. are also distributed to the needy farmers. The agricultural departments of concerned states are actually the authorities to organise and supply these subsidies to the farmers. The departments, have a number of outlets through which the distribution made easy.

The Union Government paid a substantial sum of Rs 2,200 crores in 1987-88 on depressing foodgrain prices, by way of subsidy to the Food Corporation of India to enable it to distribute food grains at less than economic cost.

Except for the subsidy paid to marginal and small farmers under the rural development programmes and for some financial aid given to SC/ST, no subsidy is directly paid to farmers. In most cases the subsidy is given in kind.

In India, 'subsidy' to the farm sector has been given a totally different meaning from what is understood by it elsewhere in the world. Subsidy for the farm sector is the money paid to farmers in excess of what they would get it they were exposed to free internal and external trade conditions.

VI. AGRICULTURAL MARKETING

Agricultural marketing involves in the simplest form the buying and selling of agricultural produce. In older days when the village economy was more or less self-sufficient the marketing of agricultural produce presented no difficulty as the farmer sold his produce directly to the consumer on a cash or barter basis.

In modern marketing, the agricultural produce has to undergo a series of transfers or exchanges from one hand to another before it finally reaches the consumer. This is achieved through three important marketing functions, viz.

(i) assembling (concentration);
(ii) processing (preparation for consumption);
(iii) distribution (dispersion).

Marketing Agencies

The transfer of produce or goods takes place through a chain of middlemen or agencies. In the primary market, the main functionaries are the producer, the village or itinerary merchant, pre-harvest contractors, commission agents, transport agents etc. In the secondary market, the

processing and manufacturing agents are the additional functionaries. Financing agents such as shroffs, banks and co-operatives may also take part. In the terminal or export market, the commercial analysis and shipping agents also get involved in the transfer of goods.

The functionaries have their own set up. They may be individually co-operatives or partners who may buy and sell on ready-and-future basis at a price determined by force of supply and demand.

Marketing Improvements

India being a primary producing country, agriculture plays a vital role both as an essential infrastructure and developmental component in generating and sustaining a higher national income. It is estimated that about 50 per cent of the agricultural produce is available as marketable surplus. The marketing system in India provides sustenance for about three million people who are engaged in performing various marketing functions. In the field of exports, too, the agricultural sector accounts for about 50 per cent of the total value.

The reasonably low return that the farmers get for their produce and the excessive margin of profit retained by intermediaries and the various malpractices rempant in the market necessarily attracted the government attention and it was felt that the economic condition of the agriculturists could not be improved unless determined steps were taken to establish an orderly system or marketing in the country.

Regulation of Markets

Prevailing market practices and market charges made a deep cut in the share of the producer in the price paid by the consumer. It was felt that a remunerative price to the market producer could only be ensured if the market practices and market charges were regulated and rationalised. Thus a regulation of the market has been given a higher priority in the various Five Year Plans. The market are sought to be regulated through an act of each state of Legislature. The Act is known as the Agricultural produce market act and it provides for their removal of various malpractices widely prevalent in the markets for the settlement of disputs between sellers and buyers and for the promotion of orderly marketing of farm produce in general.

Market Surveys

Although the first market to be regulated was Karanji (Maharashtra) in 1886, the regulation of markets did not make much headway till the first Five Year Plan. It got a fillip in the second and third Five Year Plans and by the end of March 1974 out of a total of 4,130 assembling markets, 1,777 main markets or about 43 per cent of the working of this scheme, excessive communications and other market charges

have been substantially rationalised. Unauthorised and arbitrary deductions have been prohibited and malpractices stopped.

An important development is the field of regulated market is the interest taken by the International Development Agency (IDA) in the development of infrastructure in regulated markets.

Standardization and Grading

In order to gain the confidence of the consumer and establish a rational relationship between the quality of a produce and its price, it is necessary to devote some attention to the proper preparation, shifting and sorting of a material according to certain attribute before it is taken to the market. This is sought to be achieved by grading the produce in conformity with certain accepted quality standards viz. size, shape, form, weight and other physical and technical characteristics. The produce brought to the market is very often contaminated with dust, stones and other foreign matter added either deliberately or by accident. Sometimes the produce is immature, or not properly dried or contains shrivelled grains or damaged and rotten material. Such a produce brings a lower price to the farmers.

The Government of India had recognised the need to introduce the standardization of agricultural produces and enacted the Agricultural Produce Grading and Marketing Act (APGMA) in 1937. The Act empowers the Central Government to prescribe Grade standards, indicating the quality of articles included in the Schedule and specify grade designation marks to represent particular grades or qualities. The act provides for grading and marketing of agricultural produce. The grade prescribed under the Act are designated as 'Agmark' grades.

A central Agmark laboratory at Nagpur with Sixteen Regional laboratories at various States are there to provide adequate laboratory facilities for fixing grades/standards for new commodities, for revising old grades/standards and for routine quality control work. Agmark Grade specifications have been notified for over 97 agricultural commodities, covering over 280 trade descriptions.

Contract Terms

Under the existing trade practices the sale of produces in a primary market takes place on the basis of the visual inspection of the goods, and in the secondary and terminal markets, on the inspection of samples. There after the buyer and seller decide the terms either orally or through written contracts. The contract terms specify the quality and quantity of produce, the time and place of delivery, the price and terms of payments, handling and incidental charges etc.

Regulation of Cold Stores

Most of the problems relating to the mar-

keting of fruits and vegetables can be traced to their perishability. Perishability is responsible for high marketing costs, market gluts, price fluctuations and other similar problems in the marketing of fruits and vegetables, fish, meat etc. At low temperature, perishability is considerably reduced and shelf-life of perishable products is increased and thus the importance of cold storage and refrigeration in the marketing of perishables was felt.

Significant progress in the expansion of cold storage industry in the country has been made only after the independence. The Government of India, in the Ministry of Agriculture, promulgated an order known as 'Cold Storage Order, 1964'. The order is applicable and enforcible in respect of every cold store with a capacity in excess of 8.5 cu.m.

Consumer Protection

In the marketing process, the producers and the consumers are the two weak ends of the production cycle. It is therefore incumbent on the part of the Government to protect the interests of both of them. The producers are sought to be protected through the regulation of the markets, grading etc. Consumers' interest on the other hand, is safe guarded through grading under 'Agmark' at the level of traders. With the popularity of semi-processed and ready-to-use foods, the danger of substandard food articles being marketed has increased manifold. And so was the need to protect the consumer against the consumption of such food stuffs. With this end inview, steps have been taken in many standardization of agricultural commodities, certification marks in respect of manufactured goods, pure food law, laws relating to manufacturing of fruits and vegetable products have been passed and enforced. Commodities such as cheese, vegetables, oils, butter, honey and powered spices are being graded and marked under 'Agmark'. The agmark attempts to provide a third party gurantee for the consumer.

Co-operative Marketing

The existing institutional structure of co-operative marketing is such that the co-operatives are functioning at the primary level, at the secondary level (Districts) and at the State level. Efforts have been made to persuade the state Governments to eliminate the middle ties, so that a tier system can be brought into operation in those states where the 3 tier system is in vogue. The co-operatives in different states have been federated into a Central Level Federation viz. the National Agricultural Co-operative Marketing Federation (NAFED).

Marketing is a multi-stage process. For the improvement and development of marketing structure, a co-ordinated approach aiming at removing all the weak links of the marketing chain is essential. A

package of improved marketing services in the form of regulated markets, facilities for grading, weighing, storing, transporting, handling services and marketing finances need to be made available to ensure the producer a fair return from his production efforts and a better share in the price paid by the consumer. At the same time, market research programmes should be oriented to develop an ordely and efficient marketing system. This is a crucial time in the development of agricultural marketing when the country is poised to enter an era of production surpluses. A piece meal approach at this stage can be disastrous and can nullify the advantage gained by the farmer on the production front.

CHAPTER 5

Agriculture and Environment

I. LINKAGE BETWEEN ENVIRONMENT AND AGRICULTURE

Within three of more million years of man's existence on this earth not only man progressed from the 'primitive' man to the 'technological' man but also was transformed from a 'creature' of the environment to its 'moulder'. The moulder man through his activities changed the environment into two inter-linked components – the natural environment and the socio-cultural environment. The socio-cultural component of agricultural lands has been made out of the original grass lands and forest lands of the natural environment.

Water, air, sunlight and soil are the most important requisites of agriculture. The incidence of water, air and sunlight varies with climate. Similarly success or failure of farming is determined by weather conditions. Soil, provides essential nourishment as well as anchorage to the crops. In addition to land, water and atmosphere, other two components of environment i.e. flora and fauna are also essential to sustain agriculture.

The environmental resources – energy, air, water, soils minerals, plants and animals – suffer at human hands, from wanton exploitation, blind ignorance, stupidity and neglect. It is essential for man's own survival to become aware of the limitations and carrying capacities of the environment and to find ways and means of counteracting destructive trends and bring solutions of their problems to the doorsteps of the common man.

Land Utilization

The land surface of the earth is covered by four major biological systems – forests, grass lands, crop and deserts. The total world area officially recorded by FAO under land are as per FAO Production Year Book 1981 is 13,392, 148,000 hectares. Out of this 2.36 per cent area is covered by inland bodies of water, i.e. lakes, rivers etc. Out of the remaining area the percentage of crop land, grass land, forest land and other land are 10.84, 23.27, 30.56, and 32.95 respectively.

Other land includes area occupied by roads, rail lines, constructions, human habitations, barren waste lands and deserts.

There is great variation in the distribution of the land biological systems in different regions of the world. Asia with more than half of the world's population to support possesses 31 per cent of the world's crop lands, 19 per cent of the world's grass land and 13 per cent of the world's forests. India with 15 per cent of the world's population possesses 11.6 per cent of the world's crop lands, 0.4 per cent of grass land, 1.5 per cent of forest lands and 1 per cent of other land.

The National Waste land Develop-

Land Use in percentage 1980

Country	*Total area*	*Land area*	*Agricultural land*	*Grass land*	*Forest land*	*Other land*
World	100	100	100	100	100	100
USA	6.99	6.98	13.12	7.62	6.94	4.53
USSR	16.73	17.03	15.97	11.99	22.47	15.89
India	2.45	2.27	11.64	0.38	1.85	1.10
China	7.16	7.11	6.83	7.05	2.84	11.21

Source : Estimated from data in FAO *Production Year Book 1981.*

Out of the total geographical area of 328 million hectares (mh) the land use statistics are available for only 93 per cent. 1970-71 is the latest year for which land use data are available. These data are given below.

Total geographical area	*328 mh*	
Reporting area	*306 mh*	
Arable land (net area sown+Current and other fallow lands	161.3mh	52.7%
Forest land	65.9 mh	21.6%
Grass land	13.0 mh	4.2%
Land under miscellaneous tree crop and groves	4.3 mh	1.4%
Cultivable waste land	15.2 mh	5.0%
Land under agricultural uses	16.1 mh	5.2%
Barren and uncultivable land	30.2 mh	9.9%
Total	306.2 mh	100%

Source : *Hand book of Agriculture*, ICAR, New Delhi, Revised Edition, 1980.

ment Board estimates that 80 mh out of 154 mh under cultivation requires rehabilitation. According to the forest survey of India only 36.14 mh out of 64.2 mh forest land has adequate density.

The effective forest cover is thus limited to 10.88 per cent of the geographical area. The ecological security demands that one third of the land surface should be under forest cover.

India's sixth plan document in 1980 reported that out of the total area of some 266 mh with any potential for biotic production about two-thirds (175 mh) were suffering from degradation. About 90 mh had been damaged so devastatingly that it has been officially categorised as waste lands. This means that one third of the total bio-productive areas has gone out of production. One third has turned sick and only one third is in good health.

India stands now in a very precarious situation while not much is done to halt the process of degradation. The pressure of human and cattle populations on land is steadily growing at over 2 per cent per annum. At the present rates of growth India's population will reach 1 billion mark in 2000 AD.

II. EFFECT OF AGRICULTURE ON ENVIRONMENT

Modern agriculture pivots upon high-yielding seeds, fertilizers, pesticides and irrigation. The agricultural operations in the affluent countries are highly mechanised, capital intensive, labour saving and are based on high consumption of energy derived from non-renewable sources of the earth. High-yielding varieties demand the use of more fertilisers, which in turn require more water. Wide use of high-yielding seeds, fertilisers, pesticides and provision of water through canal irrigation have given rise to several environmental problems.

Waterlogging

Irrigation from major works requires construction of costly dams and canals. Canal irrigation leads directly or indirectly to the rise of water table, culminating in waterlogging and the related problems. The Indus and its tributaries water one-eighth

Agricultural performance in India and China 1988-89

Area and production	*India*	*China*
Land under agriculture	143mh	100mh
Foodgrains production	173mt	360mt
Percapita availability of foodgrains per annum	200Kg	330Kg

Source: B.B. Vohra, Need to halt land degradation, *Survey of Indian Agriculture 1989.*

of World's irrigated area. Eighteen per cent of the gross area sown in the Indus Plane, i.e. two million hectare, is seriously damaged by waterlogging and salinity. The damage is increasing at the rate of 20,000 to 30,000 ha. per year. In India Punjab is worst affected by waterlogging. The canal irrigated agricultural lands in different parts of the country are facing the rising problems of waterlogging.

Agro-chemical Pollution

Runoff water becomes polluted with fertilizers and pesticides and pollutes the soils, canals, rivers, and seas. Polluted water inhabits fish growth. Health of man and animals is adversely affected by pesticide residues. The latter have led to the extinction of certain species, the development of resistance in pests and the outbreak of new pests.

Many agrochemicals have been banned or severally restricted for use in a number of countries and identified by the World Health Organisation as excessively toxic and hazardous. But these are freely used in many developing countries.

Among the pesticides, banned, with drawn or severally restricted in various countries but used freely in India are shown in the following table.

Besides the above many other undesirable pesticides are still in use in India the consequencies of which are not yet realised.

Deprivation of Genetic Resources

The advent of scientific plant breeding has resulted in the production of modern high-yielding varieties. These varieties are grown in many parts of the world bringing dramatic improvement in food production. But side by side these limited varieties are replacing the traditional wide range of varieties throughout the world depriving the latter of valuable genetic resources.

Current use of some hazardous pesticides in India 1982

Pesticides	*Effect*	*Current Consumption tonne/per annum*	*Area in ha*
DDT	Carcinogen	3,500 (agri.) 4,000 (Public Health)	2.5m
BHC	Highly hazardous carcinogen	33,000	11.5m
Methyl parathion	Extremely hazardous	3,000	12m
Heptachlor	Three times as toxic as DDT	150	300,000
Lindane	Moderately hazardous	60	

The loss of forest also implies the loss of habitats nurturing biological diversity. Crop and lives-stock improvement is based on the generation of superior genetic material. A continous improvement in yield and quality can be ensured only by the conservation of plant and animal genetic resources, their assessment for desirable genes and their application in cross-breeding and genetic engineering programme.

CHAPTER 6

Ways To Higher Farm Production

Although agriculture engages more than 70 per cent of India's population, its contribution in the national economy is far below any reasonable proportionate level as compared with low returns per unit input in agriculture. The low returns can further be attributed to several factors concerning land preparation, agronomic practices, plant protection, post harvest technology and so on. If all these factors are managed properly, the farm output can certainly be raised to much higher level than where it stands today. Agricultural extension services have to play a crucial role in the dissemination of appropriate research findings from laboratories to the fields of the farmers. Proper application of improved farm practises can certainly help us raising the yields of our major crops, which are miserably low as compared with other countries of the world as shown in the the following table.

It is a general observation in our country that the management of various farm input does not receive due consideration because of different reasons, which finally leads to low farm productions. Farm inputs like land, seeding materials, agricultural chemicals, energy, labour etc. are scarce. Hence they must be put through better, rational and timely use through advance planning and proper execution. Some of the important factors requiring serious consideration at all levels for in-

Average production of important crops (kg/ha) in different countries 1988

Sl.No.	*Crop*	*India*	*USA*	*USSR*	*Canada*	*Japan*	*France*	*Australia*
1.	Paddy	2487	6178	4394	–	5825	4789	6981
2.	Wheat	1995	2291	1760	1212	3621	6151	1516
3.	Maize	1271	5311	3810	5471	1800	7230	3782
4.	Potato	15968	31560	10137	25308	31389	34596	27179

Source : Fertilizer Statistics 1988-89

creasing the agricultural production are as below :

I. INPUT MANAGEMENT

Farm inputs are relatively costly. Some of them are rather constant, restricted and can hardly be increased at will, e.g. improved seeds, agricultural chemicals, electricity, diesel etc. Other inputs like labour, consulation services etc. are local specific and are influenced by factors like demand, supply, work pressure, labour laws etc. As all these inputs have peculiarities of their own, they are discussed here individually.

1. Land

A farmer has hardly any choice regarding the land. He has to do with how-so-ever land is at his disposal. Area of his land can hardly be increased for cropping without not so easy measures like purchase of additional land or cultivation of others land on contract or rent for a certain period of time. Under such circumstances the farmer must make the best use of his land by :

- knowing the land and its capabilities of crop production through soil analysis and physical examination by the experts;
- selecting the crop that can be grown best on particular type of land and give higher yields;
- conserving the soil fertility and maintaining it at a reasonably high level through adoption of package of practices including crop rotation, use of green manures, FYM and other organic manures;
- preparing the land properly and timely using the right implements in such a way that physical properties of the land are improved and it offers better conditions for seeding, seed germination and plant growth. The land preparation must arrest degradation and erosion of soil. Timely land preparation helps the plants to get more nutrients from the soil and to produce higher-yields at relatively low cost as weeds and other unwanted vegetation are destroyed and plants are provided with conditions more condusive for their luxuriant growth.

2. Manures and Fertilizers

Soil fertility is like a bank account which has to be replenished regularly in order to make withdrawals for some purpose. It is not possible to grow crops perpetually on land without making good the loss of nutrients through proper application of manures and fertilizers to the soil. Organic manures like compost, farm yard manure (FYM), green manures, oil seed cakes etc. not only supply essential nutrients to plants, but also improve physical conditions of the soil. The effect of organic manures on crops is felt over a long period of time because the – nutrients

contained in them are released quite slowly and they are not lost so easily through run off or down ward percolation of water. This is the reason why most of the organic manures are applied as basal dressing at the time of land preparation much before sowing. The manures need to be thoroughly incorporated into soil for their effective utilization by using appropriate tillage implements.

Fertilizers, on the other hand provide a certain nutrient or a combination of nutrients to plants more or less instantly as the nutrients are readily available to the plants. Hence, the fertilizers are applied to the plants in a definite well calculated quantity in several split doses at different stages of plant growth. The fertilizers can be applied as basal as well as top dressings. They can be applied directly to the soil, but some of them can even be sprayed over the crops for equally good results. For better results and higher yields the fertilizers can be applied in combination with several agrochemicals like insecticides, pesticides, weedicides, growth hormones etc. Fertilizers are relatively costly items, so they must be used properly so as to derive the highest possible returns from them by :

- applying the fertilizers in quantities determined strictly as per soil conditions, plant requirement, agronomic practices and other criteria;
- applying the fertilizers at right time during vegetative period of the plants – from sowing to harvesting;
- applying the fertilizers properly using the right method of application like broadcasting, drilling, placement, spraying etc;
- applying the fertilizers in combination with organic manures, biofertilizers so as to reduce the quantity of fertilizers without affecting the crop performance;
- applying the fertilizers in appropriate combination with plant protection chemicals to ensure better efficiency of farm labour and equipment which will ultimately lower the cost of production of the crops.

3. Seed and Planting Material

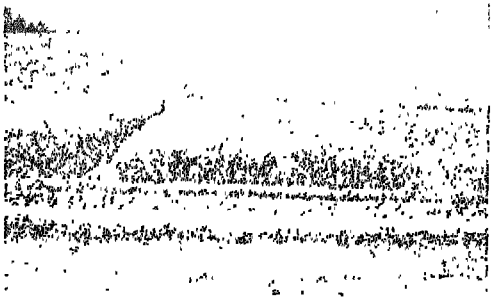
Seed is one of the most crucial inputs which can make or mar the farm production. One may reap a poor harvest in spite of using all the inputs for better farming (e.g. fertilizers, irrigation, plant protection measures etc.), if the seed sown is not appropriate. Crop yield can be increased many folds simply by using seed/planting material of improved varieties suitable to local conditions. Now a days good hybrid seeds of a number of crops (e.g. Cotton, Maize, Sorghum etc.) are available which give tremendous increase in yield by virtue of their hybrid vigour or heterosis. Similarly, planting materials of vegetively propagated crops (e.g. Sugarcane, Potato, Sweet potato etc.) ensure, near total reproduction of the properties

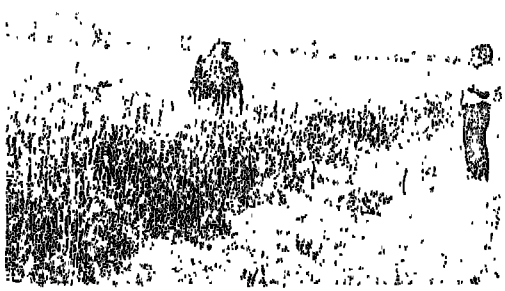
Improved seed , an important input for higher-yields, is produced through a laborious process of hybridization.

of the original improved varieties. Thus quality seed/planting material of improved varieties is the most important input for agricultural production. Although quality seed is relatively costlier, it fully justifies its application as it :

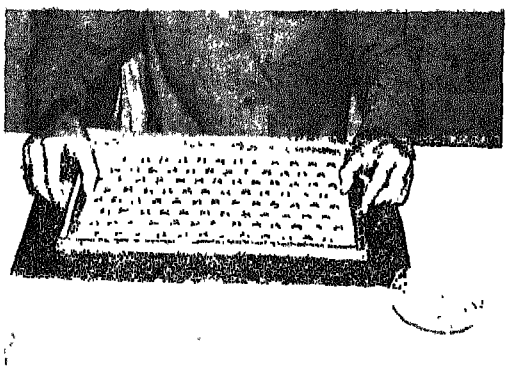
- makes better use of other farm inputs;
- ensures higher-yield and protection against pests and diseases;
- reduces cost of production as expenditure on plant protection chemicals is minimised;
- ensures quality of the produce and hence, higher economic returns.

Seed/planting material should be selected carefully and procured from reliable sources only. The seed should be well responsive to cultivation under the given conditions of the area. The seeds are generally treated with chemicals before they are sent for marketing, but if they are not treated chemically by the producer, the farmer must subject them to presowing treatment with appropriate





Promising varieties are evolved through field trials before releasing for commercial cultivation.



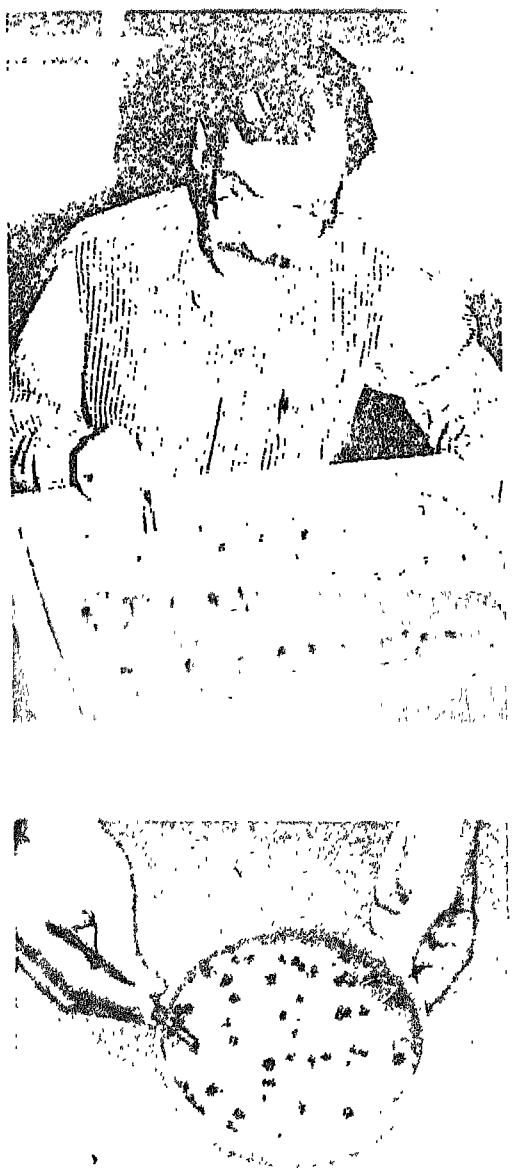
chemicals/harmones. This will doubly ensure disease pest free healthy and bumper crop.

4. Irrigation

Like any living organisms, agricultural crops require water for their vital activities. It is provided to plants through irrigation. In order to derive maximum beneficial effects of irrigation on the crops, it is essential that :

- irrigation schedule is drawn as per soil-climatic conditions of the area and requirement of the particular crops;
- irrigation quantum is determined carefully taking into consideration the quantity of water available for irrigation and duration of the crop;
- irrigation does not deteriorate physical and chemical conditions of the soil through water logging, excessive seepage of plant nutrients and soil erosion;
- irrigation water is economised by using appropriate irrigation methods, systems, equipment (drip irrigation sprinklers, *pucca* irrigation channels or G I pipes instead of open irrigation channels);
- irrigation is given at the appropriate stage of plant growth in combination with right agronomical practices.

The farmer should always remember that irrigation is like medicines to the crops, which should be given at a right



Germination test in quality control laboratory ensures reliability of the seeding material in the farmer's field.

stage in a proper quantity. Untimely application of irrigation in a quantity lesser or more than the required one, can do more harm to the crops. Crop deprived of irrigation in the early stage of their vegetative growth can hardly be benefited by irrigation in the late stage. It can be even harmful to the crops as it may cause crop lodging, prolongation of vegetative period and deterioration of the quality of the produce.

All efforts must be made to conserve soil moisture in areas where irrigation is a limiting factor and agriculture is mainly dependent on the natural precipitation.

5. Agrochemicals

Different types of chemicals have come up as an invaluable aid to increase farm production. They include plant protection chemicals, growth regulator harmones, fertilizers and soil amendments, prophylactic and therapeutic formulations against diseases of farm animals and so on. The age old golden rule "prevention is better than cure" is particularly relevent to agriculture as well. The agriculturist can be confident of reaping a rich harvest by judicious application of agrochemicals in a planned way. Their use seemingly involves monetary expenditure and labour, but it is more than recouped by way of increased farm production. Here are a few examples to illustrates the logic:

– Soil condition must be condusive for good plant growth. If needed, it can

be improved well before planting by using appropriate soil amendments like lime, gypsum etc.

- The soil must provide the basic plant nutrients in required quantity to the crops. The fertility level of the soil can be maintianed as per requirement of the crops by application of chemical fertilizers as basals and top dressings. The effectiveness of fertilizer appliction increases many folds if fertilizers are applied by appropriate methods at appropriate time.
- Presowing treatment of seed and other planting materials with appropriate chemicals protects the crops against several seed borne diseases. Similarly use of right plant protection chemicals during vegetative period of the crops does away with out break of pests and diseases. Use of plant protection chemicals in combination with biological control methods reduces expenditure, protects environment against excessive chemical pollution and ensures better harvest.
- Use of appropriate growth regulators and harmones facilities better rooting, balanced plant growth and sycronized development of plants at all phases.
- Livestock management is a vital component of modern agriculture which covers farm animals like cows, buffaloes, goats, sheep, poultry birds and many others. Successful animal husbandry is possible only through proper application of differnt chemicals, disinfectants, fumigants, medicines etc.

Thus, agrochemicals have assumed a very important place in modern argiculture. Their proper use at proper time will undoubtedly increase farm production, while their avoidance or wrong application can result in huge losses to the farmers. Enviornmental pollution, accumulation of harmful residues of agrochemicals in vegetables, fruit, milk, meat and other farm products are some of the potential dangers to human health through improper use of agro chemicals. An awareness among farmers about these aspects will help us derive the best out of application of agrochemicals in agriculture.

II. IMPROVED FARM PRACTICES

Great advances have been made in agriculture during a couple of decades which have capabilities to revolutionize agriculture. Each farm operation has certain scientific basis and the farmers perform them as per their own perception knowing the scientific principles. As a result of persistent research over a number of years, now several improved farm practices have been evolved, which do not involve significant expenditure but ensure a definite increase in farm production. These practices are crop specific and

can be easily adopted by farmers under average farming conditions. Here are a few examples of such practices :

- In wheat the first irrigation at the time of crown root initiation increases the yield many folds. Irrigation given before or after this stage is not that effective as the one given during crown root initiation stage.
- Under irrigated conditions premonsoon sowing of cotton gives considerably higher-yield of better quality in comparison with the crops sown after on set of monsoon rains.
- Presowing treatment of cotton seeds with sulphuric acid or cowdung slurry ensures proper spacing and uniformily, higher germination percentage and hence, the higher-yields.

  Presowing treatment of leguminous seeds with appropriate Rhizobium culture ensures better growth, reduction in fertilizer requirement and higher-yields.
- Earthing in groundnut at the time of peg elongation improves aeration, easy penetration of pegs into the soil, better pod development and finally increased production. This practice also helps in the eradiction of weeds from the field.
- Prompt mulching, fertilization and irrigation following harvest of the sugarcane crop help grow a healthy ratoon crop at a comparatively lower cost of cultivation.
- Use of nitrogen fixing algae in paddy crops increases the yield and reduces fertilizer requirement for the crop.

There are innumerable innovative practices pertaining to different agricultural crops which in combination with other improved practices (e.g. recycling of farm waste, use of uncoventional sources of energy, maximum utilization of farm machinary and implements, a proper crop rotation, better farm management and so on) can certainly raise farm production and elevate agriculture to the status of an economically viable profession from its generally perceived position as a mere means of livelihood for nearly 80 per cent of our fellow Indians.

CHAPTER 7

Agriculture Education

Need

Agriculture is 'the most important solar energy harvesting enterprise' which sustains the human population. With the growing human population the per capita agricultural land is gradually shrinking. On the other hand, the very future of agriculture is threatened due to mismanagement of land, water, flora, fauna and the atmosphere. For our very survival, we should be aware of our existing agricultural assets and environmental liabilities as well as the underlying scientific truth and find out the ways and means of scientific and technological application that ensure sustainable utilisation of agriculture vis-a-vis environment. We must develop required knowledge, skills and attitude and participate in activiteis which minimise environmmental degradation and maximise benefits from our agricultural assets. This is possible only through proper agriculture education imparted right from the school stage.

What is Agriculture?

Agriculture is the science and art of production of those plants and animals which are useful to man and processing of their products in varying degree for man's use and disposal.

Agriculture is concerned with the production of food crops, horticultural crops, animal husbandry, poultry, aniaml production, fisheries, forestry, sericulture. Agricultural engineering and agro-based industries, various components of basic sciences, geography, economics and statistics and technological principles enter into building up of the discipline of agriculture. Thus, agriculture is an amalgamation of quite diverse yet closely interlinked disciplines and activities.

Agricultural Components in Present School Curriculum

Presently the school curriculum in the country generally follows the national curricular frame work which was developed with the due cognizance to our pri-

orities and goals of nation building activities. Various components of agriculture are included under Environmental studies at primary level and under Science and Social Science at upper primary and secondary stages. Besides, the curriculum provides enough opportunities to initiate agriculture based activities under Work Experience Programme which is an integral part of school curriculum right up to secondary stage and is strongly recommended for the general academic stream at higher secondary stage. Thus, the rational curriculum provides exposure of agriculture to the students at all levels of school education.

At the upper primary stage, the science components of curriculum explain the students in greater details about air, water and soil, as well as the living world. They study in detail about the structure and function of roots, stems, leaves, flowers, fruits and seeds. They become aware of the concept of 'balance in nature'. They study about the basic life processes: photosynthesis by green plants, nutrition in non-green plants, respiration, transport of nutrients in plants, reproduction, about composition and formation of soil, soil erosion, conservation and soil pollution.

Orientation is given on improved agricultural practices that are basic to increase farm production, such as crop rotation, gardening, agricultural implements and their uses and care, qualitative and quantitative improvements of crop yield, improved varieties, judicious use of soil, fertilizers and pesticides, animal management, need for keeping animals, general need and maintenance of domestic animals with specific reference to cattle, sheep, poultry, bee and fish rearing are being introduced. In addition they also study about conservation of natural resources.

In social studies reference is given about the four spheres of earth – the lithosphere, atmosphere, hydrosphere and biosphere. They learn about India's natural resources, economic development in relation to agriculture.

At the secondary level they study under Science, in greater detail, about life processes (such as nutrition, photosynthesis, respiration, internal transport, reproduction) organisation of living world; habitat and adaptation, mineral cycles, recycling of waste materials and preparation of compost. They learn about environment and natural resources – exploitation of resources, ecological crises due to deforestation, management of natural resources. The students are also exposed to genetic fundamentals of plant and animal kingdoms.

In geography also they study about man and his environment, natural resources – water, land use, agriculture, agro-based industries, environmental degradation. In economics they learn about the status of agricultural occupation, contribution of agricultural sector to

Indian economy and agricultural productivity.

Need to Restructure School Curriculum

The emerging generation stands at a critical stage of human existence. The ever growing human population is gradually increasing the incompatibility between the resources and number on our planet earth.

After one decade India's population is estimated to be about one billion. Indian agriculture will have to feed one billion people. The menacing scale of environmental degradation is going to seal the fate of agriculture which can be sustained only if the enviornment is sustained.

It is therefore, essential for the upcoming generation to be better acquainted with environment and agriculture vis-a-vis human existence on earth. Such awareness can be better generated among students through a well balanced school curriculum highlighting the significance of agriculture and allied activities for survival of the human race. For this purpose it is necessary to effect certain changes in the school curriculum so that the latter incorporates the required elements of agriculture education in its fold. This knowledge will not only widen the mental horizons of the students but also encourage them to contribute their mites towards national economy through pursuit of a host of agriculture related activities like crop production, animal husbandry, fishery, sericulture, agro-based industries and so on. The scope is unlimited. What is needed for their successful execution is the right enlightment of students about the wonder world of agriculture through a suitably restructured school curriculum.

Development of Human Resources

Development of sustainable agriculture, ensuring ecological security and realisation of the potential productivity from our agriculture require development of human resources at all levels. Our country has made substantial progress during the last four decades in developing the basic infrastructure needed for sustained agricultural progress. The country now has vast network of agricultural universities, central institutes, and All-India co-ordinated research mechanisms. Those institutions are able to develop appropriate technologies suitable to the specific agro-climatic and socio-economic conditions existing in different parts of the country. Agricultural research had been made relevant by establishing linkages between R and D institutions and farmer's fields through lab-to-land. National demonstrations, Kirishi Vigyan Kendras, operational research projects and similar programmes. In the field of services, a network of extension and input supply services had been developed.

But what has been achieved is not

enough. The challenges faced by us require human resources development through education and training at all levels.

Development of Competent Skilled Work Force in School

Transfer of technologies from lab-to-field is a tremendous work. Development of a cadre of vocationally competent persons in different agricultural vocations is essential which can enable the country to transfer the skills of improved and new agricultural practices to all the farmers and farm workers working in allied areas. The immensity of fulfilling the objective can be visualised only when we realise that about 70 per cent of our working force is engaged in agriculture.

Therfore, it is a welcome step to offer competencies based vocational courses of two years duration at higher secondary stage. In the area of agiculture the students now have a variety of vocational courses to choose from. Courses like crop production, sericulture, horticulture, dairying, inland fisheries and others are immensely popular as they offer good prospects or self as well as wage employement for the students. In both cases the students not only generate good income from their respective vocations, but also serve as good extension workers. They bring new technologies and practices to their work place, evolve appropriate technologies locally to suit the area-specific conditions and encourage the neighbourhood farmers to adopt better techniques for higher farm production. These vocational courses are generally run in schools in collaboration with some industries/establishments related to these vocations. This ensures good theoretical exposure, thorough practical exposure, broader vision of the vocations in the vocational students.

Non-formal Education

The process of preparing vocationally competent manpower is not restricted to schools alone. Several agencies government, private, voluntary are actively engaged in this huge task through non-formal education programme. Need based and locale specific courses of various durations are offered in various vocational areas. The trainees receive good practical training that helps them to earn their livelihood confidently. Such non-formal education programmes are particularly useful to those persons who are unable to keep themselves in formal education system due to several constraints or are already in the world of works. Such non-formal education programmes are designed keeping in view educational background of the trainees and their needs.

Agricultural Schools

These schools are run by the state government as well as by agricultural universi-

ties. Their curricula vary from state to state regarding duration and course contents. Rural school dropouts with at least primary education are generally admitted to these schools. The curriculum is essentially agriculture biased and aims at training the students in various agriucultural activities like crop production, plant propagation, nursery management and other subsidiary enterprises with greater emphasis on practical works. Curricula of some schools even provide opportunity of further education in formal education system. These are usually residential schools and the students receive stipend as an incentive to continue their study.

Krishi Vigyan Kendras (KVKs)

These Kendras are financed by the Indian Council of Agricultural Research and are run under administrative control of government, autonomous and voluntary agencies. The present network of about 90 KVKs is planned to be expanded manifold so that at least one KVK functions in each district. The KVKs have full autonomy to develop their own programmes in consultation with the state development departments and agencies in conformity with the local needs. Accordingly, the training programmes are of the most diverse nature and duration. The main objective of the KVKs is to impart practical training through work experience and to develop scientific temper in persons engaged in the pursuit of various agricultural activities at grass-root level. The trianees are also paid stipends as incentive during their entire training programmes which last from few weeks to few months.

Farmer's Training Centres (FTC)

These training centres were established with the main objective of educating and training the farmer families in their own environment about the application of new technologies for growing high-yielding varieties of agricultural crops. The farmers are also trained to solve their various problems by using appropriate technologies. At present there are about 150 Farmer's Training Centres in the country. These centres mainly run three types of programmes viz.

(i) institutional programmes;
(ii) production-cum-demonstration training programmes;
(iii) voluntary discussion groups.

These programmes are of different durations and their course are determined as per needs and intersets of the farmers. Extension methods including the use of audio-visual aids find wider application in the conduct of these programmes. The farmers are provided with free lodging, boarding and travel expenses as incentives to actively participate in these programmes.

Higher Education in Agriculture

There are at present 26 Agricultural Uni-

versities in the country which are concerned with higher education in agriculture. Students who have successfully completed higher secondary education have access to the agricultural universities. It is meant for men and women who will occupy leading position in scientific farming, shaping agricultural policy, agricultural research, administration and a wide range of agricultural services and industries in agriculture. At present in most of these agricultural universities the broad academic programmes consist of crop production, animal production, veterinary services, agricultural economics, extension education and comunication, soil science, forestry, fishery, horticulture and dairy technology. Some of the universities have sericulture and home science programmes. Most of the universities offer degree programmes in agriculture, horticulture, sericulture, marketing and co-operation, fisheries, dairy science, veterinary and forestry leading to master and doctoral degrees.

Besides teaching and research programmes, the agricultural universities are engaged in limited extension services. The university extension programmes are designed to help personnel engaged in extension work as well as farmers. Field extension work by Extension Guides and Extension consultancy programmes benefit the farmers directly. Some universities institute correspondence course on different agricultural enterprises which last for 3 to 4 months. After successful completion of the programme the participants are given certificates.

Thus, we see that the process of educating our youth – both rural and urban and the farming communities is bring conducted in a variety of ways involving the traditional formal education system as well as unconventional non-formal system. of education.